Science Education

SCIENCE IN GENERAL EDUCATION AT THE COLLEGE LEVEL *

LLOYD W. TAYLOR
Oberlin College

A few years ago I was inspecting the collection of portraits of Sir Isaac Newton in the British Museum. The Museum keeps a file of negatives of portraits that are in the greatest demand, and I inquired whether that file included any of Newton. The attendant looked at me in evident perplexity for a moment and then replied: "Oh, no sir. We 'as 'em of the fymous men, sir, but not 'im, sir!"

Most of you can cite closer instances of a similar obtuseness with reference to the importance of the sciences. Nevertheless we all believe that the sciences have a unique contribution to make to the educational program. Until fairly recent years the sciences in the educational scheme were riding a strong wave of popular approval which originated in the last quarter of the nineteenth century. But lately there has been a reaction and the tendency is now in the opposite direction. This is being reflected in shrinking registrations in the high school sciences, with the disquieting statistics of which you are doubtless better acquainted than I.

But the subject assigned to me is science in general education at the college level. In the colleges and universities it is not so easy to see the trends that are so clearly evident in the secondary schools. Trends of sentiment toward the science in colleges and universities are obscured somewhat by the effect of the science requirement and by the rapid increase in total college registrations during the last generation. It is possible to analyze such trends, though it is seldom done. Such a study was recently made in one midwestern university which is probably typical of most others. It was found that the proportion of students electing work in the various sciences outside of the science requirement had diminished in the short space of three years to levels averaging less than one-third of the original, without members of the departments involved being in any way aware of it. The general over-all trend in science elections had been sharply downward during a time when they had been considered to be the reverse. The science departments in this university were appalled at the facts thus uncovered, and have taken vigorous steps to correct the situation. It would appear that similar studies elsewhere would be salutary. A set of instructions on how to do it is in preparation.

Nor is mere diminution in numbers the only occasion for apprehension. The following paragraph was contained in a letter from the head of the physics department in another of the larger midwestern universities six months ago, and is quoted with his permission. He said:

> Here is the thing in which I have been most interested. There are many students who do not take physics because it is too hard. This class of students does not bother me. What *has* worried me is the large number of *superior* students who do not take physics because they think it has little educational value. I have thought about this problem a great deal, but I am not altogether happy about the remedies I have tried.

This expression of uneasiness about the acceptability of our offerings in physics to those whose interest in the subject is not primarily professional is representative of

* Invited paper, given before the American Science Teachers' Association at its meeting at Columbus, Ohio, on December 28, 1939.

a rather widespread sentiment through all of the sciences. A year and a half ago information was collected by a special committee of the A.A.A.S. which shows this trend rather clearly. Of more than a thousand college teachers who give testimony on this point, somewhat over two-thirds are clearly of the opinion that "the conventional introductory college course in (their respective sciences) is more appropriate for students who later specialize . . . than for those who do not."

The fact that less than one-third of a mature group of college teachers of the sciences possesses unqualified confidence in the value of the traditional first-year courses to non-majors raises several questions. What do they think is wrong with these courses? Along what lines would they undertake improvement? What has brought about their impression of the inadequacy of the first-year science courses to the purposes of general education? These are not easy questions to answer, but a partial indication of how the thoughts of college and university teachers of science run may be adduced from the committees' studies.

I digress a moment to remark that the figures that I am using are those coming out of the studies of the A.A.A.S. Committee on Improvement of Science in General Education,* about which many of you know. This is in no sense a report of that committee. I tried to make it clear to the program chairman that though I should feel free to use some of the results of that committee's studies, I did not wish to be limited to them. Some of the subtopics which I shall treat did not come before the committee for consideration at all, and others, I am sure, would meet with dissent from some of its members. I therefore hereby absolve the committee from any responsibility for anything that I shall say while making considerable use of the results of its studies.

In the course of its investigation the committee received replies from more than 1000 college and university teachers to the question: "What do you believe are the most significant contributions which a study of (your science) should make to those students who are not to specialize in it?" More than 80 per cent felt that one of the most important contributions was to develop the ability to do critical thinking. All of the rest, except 3 per cent, believed this to be of some importance, though they did not accord it so high a place. This is an interesting response in several respects. For one thing, development of the ability to do critical thinking seems to have been considered the *most* important contribution that the sciences can make to general education, for none of the suggested alternative answers received as large a vote as this and there was no significant trend in the supplementary answers. It is perhaps natural that the physical sciences (physics, chemistry, mathematics) were somewhat more categorical on this point than the others, critical thinking being given first place by an 84 per cent vote in the physical sciences and a 76 per cent vote in the others. In my opinion, this gives to the non-physical sciences the palm for the more critical thinking about critical thinking.

I make this remark with some measure of seriousness. The ability to do critical thinking has been the central quest of the educational process ever since education came to be one of the significant cultural values. There seems to be no question but that the educational process as a whole aids greatly in the development of this desirable trait, but it is my understanding that there is room for a great deal of question about the superiority of any one subject over another in this respect. I know of no evidence to indicate that men of science are able to think any more critically about such issues as the complicated political situation

* Statistics compiled by L. M. Heil and P. E. Schaefer, research assistants to the committee.

in the world at large today than are men of equal training in other fields. Let us not forget that two generations ago a virtual monopoly on training in the ability to do critical thinking was declared by the ancient languages. In those days the attempt to develop critical thinking was called "formal discipline." When the bubble of formal discipline was pricked by modern educational psychology, the humanities experienced a major loss in prestige, much to the impoverishment of the educational world. The sciences will do well to try to avoid a similar debacle, but they have already gone far toward committing themselves to an educational theory that has points of similarity to that which proved the undoing of the classics.

Considerable unanimity was reached also on another point. Seventy-four per cent of those answering the same question, namely as to the most significant contributions which the study of their respective sciences should make to non-specialists, attributed great importance to making students familiar with the facts, principles and concepts of the science in question. All except two per cent of those remaining felt that this possessed some importance, though they did not accord it as high a place as did the 74 per cent. The importance of subject matter is a much more secure position to take, in my judgment, than to urge the preeminence of science as training in critical thinking. I cannot help connecting the favorable attitude toward the critical thinking question with the large agreement, already commented upon, that our general courses are not as well designed as they might be to meet the requirements of non-specialists. That a good training in subject matter does promote ability to think critically *about that subject* can scarcely be gainsaid. May not the uneasiness which so many felt about the value of the subject matter itself have led them to seize upon the critical thinking doctrine to bolster up a waning faith in their present classroom procedures?

This interpretation receives some support in the answers given to another question. Seventy-six per cent considered very important the clarification of a point of view for teachers concerning the place of science in general education. Less than five per cent considered it of no importance. It seems fairly obvious that this question would not have been answered that way unless some need were being felt for such clarification. My own feelings on the worth-while-ness of the efforts made by the Committee on the Improvement of Science in General Education have run the complete gamut from optimism to profound pessimism several times. But I always come back to the response to this question. I am now inclined to think that the whole, somewhat cumbersome, undertaking could be justified on the basis of that one answer alone. My moments of discouragement have usually been occasioned by contact with the conservatives of the higher educational world. They are, for the most part, men who, primarily subject matter specialists as are substantially all who are engaged in college and university teaching, seem to have allowed a natural preoccupation with subject matter to divert them from the problems of how most effectively to administer instruction in such subject matter. In some cases the preoccupation has been with research, in others with the training of specialists in their own or allied fields, a very different undertaking than the problem of fitting one's subject into a matrix of general education. Many of these men seem not to sense at all the change in the teaching problem which has been brought about by the great mass movement toward higher education that has occurred in this country during the last fifty years.

The existence of this conservative element, and some comprehension of its cause, seems to have been recognized by many, for

62 per cent of the replies assented to the suggestion that the emphasis placed on "pure research" as a basis for advancement has retarded the development of a real concern about, and research upon, teaching problems related to general introductory courses in the sciences. The first step toward the removal of a handicap is a clear recognition of its existence and nature. If in addition to this there is a general demand for clarification of the problems created in part by this handicap, that fact would seem to be of considerable significance, and the establishment of it worth a good deal of labor.

One needs all the optimism available, however, upon turning from the gratifying degree of recognition of a teaching problem to the measures that have been put into operation in the attempt to solve the problem. Not that there is any lack of such ventures. An annotated list prepared for the committee covered 35 single-spaced pages. It reminds one somewhat of the old expression about the man who mounted his horse and rode off in all directions at the same time. Unfortunately it seems to disclose a certain bankruptcy on the part of college teachers of science in the matter of a philosophy of the educational process. Until we can make up our collective mind on what we are trying to do with science as an element in general education at the college level we are not likely to do much of anything with it. We college teachers are inclined to be "sniffy" about the doctrinaire attitudes of many leaders in secondary education toward the educational process. But with all their vagueness about "functionalism," the "socialized curriculum" and all that, there is a nucleus of agreement among secondary school teachers about what they are trying to accomplish which we college teachers may well envy.

Another lesson can be drawn from a perusal of this list of experiments now under way in the teaching of science for purposes of general education. It is that the value of such experiments can be enhanced by an explicit statement of objectives and provision for testing the extent to which the objectives have been attained. These are, of course, not always possible. Educational objectives do not always lend themselves to a catalog arrangement, and even more often, the tests of their attainment cannot be administered until the student has been out of college for twenty years and even then not by conventional examinations. Teaching, even the teaching of science, is more of an art than a science and will always remain so. But even after all this has been realized, almost anyone would be impressed by the absence of control on teaching experiments constituting this 35-page list, under circumstances where it would appear that some measure of control, at least, was entirely feasible. Many teachers, especially in colleges, do not realize the extent to which techniques have been developed in recent years, capable of measuring with considerable accuracy the degree to which such aims as can be made explicit are achieved by teaching. Many teaching experiments are fading out in futility solely for lack of the application of perfectly feasible tests by which the results could be demonstrated to others.

During its deliberations the committee found itself facing repeatedly the desirability of the establishment of a central clearing house to which teaching problems in the sciences could be brought for bibliographical aid and for information as to unpublished current ventures in other quarters. Such a bureau could reduce duplication of effort, suggest areas which seemed to be unexplored and in general help to organize and vitalize a phase of science teaching which sadly needs cooperative assistance. The present list of teaching experiments could constitute one of the points of departure for such a bureau. While broadcast publication of that list might do more harm than good, the bureau could put it at the disposal of those who were demonstrably in a position to profit by its use.

Another type of working material which the committee would add to the assets of such a bureau would be the bibliography, compiled for the use of the committee, consisting at present of some 600 entries, about half of them annotated. The present indication is that the function of a central clearing house of this nature can be performed by some one of several appropriate agencies already in existence. Arrangements to that end are already under way and when completed will be announced.

There are those who deprecate any suggestion that the mode of presentation of the sciences should be changed to adapt them to the changing requirements of higher education. This attitude seems to be taken partly because the individual is not convinced that the sciences have anything to gain by such a change, and partly through a fear that academic standards will be jeopardized by such a change. Both of these objections are understandable and merit a candid reply. While this may not be the most appropriate time to make such a reply, I am venturing to suggest some respects in which it seems to me that the objections are not entirely valid. Let me deal first with some negative aspects.

First let it be realized that any suggested reformulation of science instruction applies only to a limited portion of the science student body. Only terminal first-year courses are under discussion. We are considering solely the requirements of students for whom the general course will constitute the only experience in that field. Whatever revision in the conduct of pre-professional courses may be appropriate is no concern of the present inquiry. We are dealing only with the reformulation of science instruction for the purposes of general education. That is, however, no small undertaking. Thanks partly to the science requirement, it involves the majority of students in the liberal arts.

Second, there is no implication that the science courses, as reformulated for this group of students, should be on an intellectual plane that is one whit lower than that upon which the conventional courses are pitched. On the contrary, any error that is made in judging this level should be on the side of the arts science courses requiring more rather than less ability and application on the part of the student than the pre-professional science courses. An amazing wall of resistance has been built up against experimentation in this field on the assumption that any such venture is necessarily in the direction of relaxation of intellectual standards. The damaging part of that assumption lies in the fact that so many teachers who have ventured into this field have themselves apparently had the same feeling, with the inevitable result that the courses which they have evolved have been open to serious criticism on the basis of their superficiality. Teachers who have taken this position have done a major disservice to the cause which they have been attempting to serve. It should be quite clear that, at a time when any effort in this direction, however meritorious, is bound to come under fire from the conservative element, they have given their critics the best possible ground for the most devastating form of criticism. I can see no escape from the conclusion that mere prudence, if no other factor, must result in pitching any modification of the traditional science courses on a plane well worthy of the mettle of the best students. Any attempt which is based on an assumption that the general level of ability of those who are not expecting to continue with the subject is less than that of those who are is doomed to ultimate failure.

A third misapprehension, which is perhaps a subhead of the second, is the feeling that to convert the conventional general course in science to one adapted to general education, about all that needs to be done is to omit some of the more technical material. The whole sorry scheme of starred paragraphs in textbooks is an outgrowth of this misapprehension. It should scarcely be necessary to remark that this is attack-

ing the problem at precisely the wrong end. Our students are human beings, candidates for *general* education, before they are engineers or physicists or zoologists, candidates for *professional* education. If the preparation of either is to be the more extensive, it should be that of the candidate for general education, with starred paragraphs in his textbook to limit it to the narrower requirements of the specialist. It would probably be more discriminating, however, to recognize that each group has its peculiar requirements, and that any attempt to overlap the two, at least without supplementary separate instruction, is certain to prejudice the interests of one group or the other.

This brings us to the main point: What really is the central objective of the sciences as curricular elements in general education? One of the implications of the foregoing paragraph was that science courses for general education should be more extensive than they are usually found to be; that they should give more attention than they now do to the requirements of general education at the college level. It is entirely fair to require anyone who subscribes to this assertion to justify it. There is some ground for a contention that the sciences have done very well by themselves through staying in their own technological back yard. Why worry about what the neighbors think? Let us continue (so we are urged) the strategy that has been so productive up to the present. This is a fair question, as I have already said. Notwithstanding the fact that this is a phase of the subject to which I have given considerable thought, I feel the need of some support in maintaining my position. I shall therefore at several points quote from writers who have had occasion to comment in this field.

We live in what is frequently termed the scientific era. General education rightfully looks to the science to show why this is a correct characterization and what such a characterization implies. Unless the sciences live up to this responsibility, society will lose sight of the real place of science in the social order. Lord Acton once said:[1]

> There may be, perhaps, a score or two dozen decisive and characteristic views that govern the world, and that every man should master in order to understand his age.

Lord Acton would surely have included a comprehension of the scientific method as one of these views, the one which takes a place of precedence in understanding the present age. Yet how much real comprehension of it does the average educated man possess? R. E. Lee answered the question four years ago in this way:

> In spite of the fact that science has tinged every aspect of the world, the attitude of the man who lives on Main Street toward scientific knowledge is highly capricious and varied. In one breath he proclaims the pure scientist as a highbrow and an impractical theorist; in another he anathematizes him for disturbing the social order and blasphemously undermining his religious beliefs; but at the mention of a name like Edison, he conjures up a sort of superman, before whom he falls in a sort of coma of veneration. At one moment this resident accepts unquestioningly a knowledge he does not fully understand, yet at another he is thrown into hysteria by the challenge of one of its basic conceptions. Such contradictory mental attitudes may be traced not infrequently to the failure of individuals to grasp the real *meaning* of science. To be *appreciative* of the merits of science is something more than to be *merely impressed* by its achievements.[2]

One may agree with Lee and yet not concede that it is the proper function of the *sciences* to provide this element of comprehension of the scientific method. There are those who maintain that interpretation of science is the function of philosophy rather than of science itself. This has been tried, however, and found wanting, partly on account of lack of an adequate knowledge on the part of philosophers, of subject matter in the fields which they were attempting

[1] Quoted by President Conant, *President's Report*, March, 1937, p. 10.

[2] Lee, R. E. *Man the Universe Builder*. Williams and Wilkins, 1935. p. 37.

to interpret, though I suspect that this is not the deepest seat of the trouble. In any case this condition is destined to become worse instead of better as the sciences steadily become more complex. It is growing clear that the interpretive responsibility must be discharged by the sciences themselves if it is to have any chance of being done well. Frederick Barry in his *Scientific Habit of Thought* says:

> The ultimate establishment of more liberal elementary courses in science cannot be avoided. It is necessary to our purpose that the humanistic liberalization of scientific studies be powerfully advocated and actively encouraged and at once; for the obvious reason that we must depend on the scientists to devise our basic cultural courses in science.[3]

H. D. Gideonse, formerly of Chicago, recently appointed to the presidency of Brooklyn University, remarked a year ago:

> Science as usually taught to liberal arts students emphasizes results rather than methods, and tries to teach techniques rather than to give insight into and understanding of, the scientific habit of thought. What is needed, however, is not a dose of metaphysics, but a truly humanistic teaching of science.[4]

We will all admit that we are at present very inadequately trained to make the contribution which Gideonse suggests. We in the colleges are primarily subject matter specialists and only secondarily educators. This has in large measure been brought about by the adoption of the Ph.D. fetish in higher education, together with the narrowness of the qualifications that graduate schools have established for the doctorate. With the best will in the world, even in the case of one who resolutely puts behind him all conscious consideration of professional recognition and advancement, it is very difficult to give the same heartiness of effort to the non-specialist majority that is spontaneously lavished on the specialist minority. To overcome this tendency will require a pronounced about-face by college teachers of science, but it must be overcome, and our curricular offerings be enriched, if the sciences are to continue as a major factor in the scheme of general education. President Emeritus Neilson has recently said:

> Especially in the natural sciences is it the case that the temptation to early and intense specialization has produced a specialist capable of training other specialists, but ill adapted to educating youth between seventeen and twenty-two.[5]

It is still possible for the doubter to demand a bill of particulars. What is the nature of the humanistic element that is thus to be injected into our science teaching? How can it be acquired and transmitted? These, too, are fair questions, but the statute of limitations confines me to a woefully inadequate answer. One could scarcely do justice to the subject in less than a whole address or, better, yet, a whole book. But briefly, of several possible approaches to this problem, the one that impresses me as the most promising is, while retaining substantially the present arrangement of general courses in the sciences and the basic alignment of subject matter in each course, to place that subject matter in a setting of the history of its development. In my extremity, let me once more invoke the statements of others on this point.

> President Conant recently said: Much of the significance of accumulated knowledge lies in an understanding of the process by which it was accumulated.[6]
>
> The historical investigation of the development of a science is most needful, lest the principles treasured up in it become a system of half-understood prescripts or, worse, a system of prejudices. Historical investigation not only promotes the understanding of that which now is, but also brings new possibilities before us by showing that which exists to be in great

[3] Barry, Frederick. *The Scientific Habit of Thought.* Columbia University Press, 1927. p. 321.

[4] Bulletin American Association of University Professors 24: 376 (1938).

[5] Bulletin American Association of University Professors 25: 591 (1939).

[6] Bulletin Association of American Colleges, 23: 43 (1937).

measure *conventional* and *accidental.* From the higher point of view at which different paths of thought converge, we may look about us with freer powers of vision and discover routes before unknown.[7]

A. S. Adams in the *American Physics Teacher* four years ago asked:

> Can we not lead the student to a greater appreciation of the significance of science by acquainting him with the toilsome thought that has gone into the discovery and confirmation of the scientific facts that we accept so readily? . . . In order to have real meaning, the student's growth in the knowledge of a science must bear some relation to the growth of the science itself.[8]

Wilhelm Ostwald once remarked:

> While by the present methods of teaching, a knowledge of science in its present state of advancement is imparted very successfully, eminent and far-sighted men have repeatedly been obliged to point out a defect which too often attaches to the present scientific education of our youth. It is the absence of the historical sense and the lack of knowledge of the great researches upon which the edifice of science rests.[9]

Ostwald's complaint of 50 years ago is still valid for us. Even after the desirability of making more use of the historical element in science instruction is established, there will remain the major undertaking of training teachers who are competent in the field of the history of their sciences. This is at present a sadly neglected field. Frederick Barry supplements the statement which I quoted earlier by remarking:

> Our first and most urgent necessity is the training of humanistic scientists. This task is one which has never yet been attempted and will probably be very difficult of accomplishment, particularly since it will necessitate the introduction into science curricula, both elementary and advanced, of studies which, to the now typical scientific mind are either uninteresting or repugnant.[10]

Barry's statement raises a very large question which however, is outside of the field to which I am now addressing myself. It is the problem of the education of teachers of science, at all educational levels, to meet the new requirements which a rapidly chang ng social order is making of the educational world. It is a problem which should be of particular interest to colleges and universities, for at least three reasons. One is the necessity of broadening their own teachers. Another is that they bear the responsibility for the education of teachers of primary and secondary schools, both of whom must contribute to science education if an increasingly critical public is not to eliminate the sciences from the educational scheme entirely. And the third is the fact which is growing clearer to me every day that when the ideal program of teacher education is worked out it will be found to be surprisingly close to the ideal program of general education.

But all this, central though it is in the thinking of such a group as this, is aside from the main theme of the moment. In urging the appropriateness of more emphasis on the historical element in science instruction, I am not suggesting a substitution of the *history* of science for the *study* of science itself. On the contrary, such a venture, to be successful, must hew pretty much to the conventional line of subject matter already in vogue. But the stage should be set with historical wings and backdrops. As subtopics are taken up in the usual order, the story of their development will shed a new light, not only on their present significance as scientific concepts, but on how they contributed to the birth of the sciences and to the dawning of the scientific ear. When the subject is developed in this way, the time involved is not at all proportional to the extra ground covered, since in the main the process consists of rearranging, from another point of view, material already involved or implied in the traditional science courses.

Neither do I take the position that the historical approach is the only way in which the sciences can adapt themselves to the requirements of general education which

[7] Mach, Ernst. *The Science of Mechanics.* Open Court Publishing Co., 1907. p. 225.
[8] American Physics Teachers 3: 62 (1935).
[9] Cajori, F. *A History of Physics.* Macmillan, 1929 (see Preface).
[10] *The Scientific Habit of Thought.* p. 322.

are pressing in on us with ever greater and quite proper insistence. I am sure that there are other ways. But to me, it seems the solution lying most readily at hand and which can be exploited to the best effect. But whether that method or some other is adopted, a heavy responsibility rests upon college and university teachers of science to adapt their offerings, in one way or another, to the changing requirements of a rapidly evolving educational scheme. The American mass movement toward higher education has no parallel. We have no precedents to guide us. But we shall be wise, perhaps, with the wisdom of self-preservation if we recognize this new responsibility and marshal all our pedagogical resources to meet it.

SCALING THE INTANGIBLES: A SECOND STUDY

Frederick T. Howard
Northwest Missouri State Teachers College, Maryville, Missouri
AND
M. L. Robertson
New York University

During the past fifteen years an understanding of the scientific attitudes has become accepted among progressive educators as one of the major objectives of science education. While, through objective measurements, the social attitudes have been explored rather carefully, there have been few significant measures prepared for specific scientific attitudes. This study is a continuation of an attempt to meet the need for objective scales suitable for measuring such attitudes. A previous study [1] provided a scale for the evaluation of the attitude "Sensitive Curiosity." It is the purpose of the present study to construct a device suitable for measuring the effects of science instruction upon the scientific attitude "Conviction of Cause and Effect Relations." The methods of instruction for teaching an understanding of the attitude in science courses or the arrangement of the content in such courses are not pertinent to the purposes of this investigation. No attempt will be made to evaluate overt behavior.

[1] Edwards, Lon, and Robertson, M. L. "The Construction of a Scale for the Determination of the Scientific Attitude 'Sensitive Curiosity'." *Science Education* 23: 198–206; April, 1939.

ASSUMPTIONS

A. The concept attitude is defined for the purposes of this study as a "mind set," a tendency to act in a certain way when faced by a problematic situation, a way of looking at things, or a predisposition to action.

B. Curtis' [2] definition of the attitude involved is accepted for the purposes of this study:

Conviction of universal basic cause and effect relations, rendering untenable

1. Superstitious beliefs in general, as signs of good or bad luck, and charms;
2. Unexplainable mysteries;
3. Beats all attitude, commonly revealed by
   a. Too ready credulity;
   b. Tendency to magnify coincidence.

C. An opinion is a verbal or written expression of an attitude. It is restricted in this study to an acceptance or rejection of a statement which supposedly expresses an attitude of the individual.

METHOD

"Paper and pencil" testing procedures are used in this study because of the ease

[2] Curtis, Francis D. "A Determination of the Scientific Attitudes." *Journal of Chemical Education* 3: 927; August, 1926.

in administration and the minimum possibilities of misinterpretation. The particular type of "paper and pencil" test selected for use here is the method of equal appearing intervals or the psycho-physical technique as reported in a study by Thurstone and Chave [3]. Four significant changes have been made in this technique as used in the present study:

1. The scale has been shortened from eleven to nine points.
2. The statements have been rated by a few experts in the field of science education rather than by a large number of untrained individuals.
3. The scale values of the statements were obtained by formula rather than by graphical methods.
4. The judges were asked to place the items in categories rather than at some point to the right or left of the midpoint of a linear scale.

Probably the most difficult and the most important step in the construction of an attitude scale is the compilation of a satisfactory list of statements or items. From previous studies, popular books and magazines, newspapers, radio, motion pictures, classroom situations, and everyday experiences, ideas which involve cause and effect relationships were collected. The items were selected and written in such a manner that, as nearly as was possible, all points on the attitude variable might be represented. The writers, as have other investigators, found it particularly difficult to secure a good distribution of items through the middle portion of the scale. A total of 180 items were compiled and tentatively accepted on the basis of the following criteria, suggested by Thurstone and Chave: [3]

1. As far as possible, the opinions should reflect the present attitude of the subject rather than his attitude in the past.
2. It has been found that double-barreled statements tend to be ambiguous. The material should be so edited that each opinion expresses as far as possible only one idea or thought.
3. One should avoid statements which are evidently applicable to a very restricted range of indorsers.
4. Each opinion selected for the attitude scale should preferably be such that it is not possible for subjects from both ends of the scale to indorse it.
5. As far as possible the statements should be free from related and confusing concepts.
6. Other things being equal, slang may be avoided except where it serves the purpose of describing an attitude more briefly than it could otherwise be stated.

In order to establish some validity for the items the full list of 180 items was submitted to six people experienced in the construction of attitude scales. These judges were asked to rate each item on the basis of the following criteria:

1. That the item involves understanding of cause and effect relations.
2. That it does not involve understanding of cause and effect relations.
3. That it has doubtful value.

No item was retained for the final list which had been rejected by a single judge. The returns from the six judges were examined and a tentative list of 150 items was prepared.

Thurstone and Chave asked laymen to classify their items into the various categories in order that the values of the items might be determined. For the purpose of the present study, it appeared to be more defensible and more convenient to use a smaller number of educational experts as judges. Members of the National Association for Research in Science Teaching were assumed to be experts in the field of science education. Letters were written to fifty-five members of this organization, of which number thirty-seven consented to cooperate in the study.

The 150 statements of opinion were mimeographed and the sheets of paper cut into small individual slips. Sets of the 150 item-strips were sent to each of the thirty-seven individuals who had signified their willingness to cooperate in the study. Each

[3] Thurstone, L. L., and Chave, E. J. *The Measurement of Attitude.* Chicago: The University of Chicago Press, 1932.

of the judges also received nine envelopes distinguished only by the letters "A" to "I." In the directions to the judges, they were asked to read the statements and sort them first into three piles. The pile placed on envelope "B" was to indicate the lowest degree of the attitude, on "H" the highest degree, and the "E" pile was to include the neutral statements. The judges were further instructed to separate each of the three piles into three additional piles or categories which would make finer distinctions between the degrees of the attitude as possessed by a person who would accept any one of the statements. Each judge was given full freedom in assigning the items according to his own best judgment.

Twenty-five of the science experts chosen as judges returned the packets of items rated by them. One judge had failed to follow instructions properly and it was necessary to discard his work.

As a criterion of carelessness or indifferance on the part of raters, Thurstone and Chave eliminated the work of any judge who placed more than an arbitrarily determined number of items in any one category. Applying a similar criterion in this study means that the work of judges who placed more than 43 items in any one group would be eliminated. The groups of items as rated by twelve judges were retained for the final tabulation.

The distribution of the 150 items into the nine categories by the twelve judges was tabulated and summarized.

In order to give the items or opinionated statements which had been scaled into categories numerical values the low or "A" end of the scale was arbitrarily given a value of zero. Categories "A" to "I" were then given interval values of from 0–1 to 8–9 respectively. This made it possible to calculate the scale values and Q-values.

The scale value of each item is the median of the distribution of the item into the nine categories by the twelve judges. The Q-value or quartile deviation is one-half of the scalar distance between the first and the third quartiles. Odell's [4] formulae were used in calculating these values.

Regardless of how carefully a statement may be written it will not mean the same to all individuals reading and rating it. Even if a statement did mean the same to all raters it would not elicit the same response from all of them. If neither the meaning of an item nor the reaction pattern of the judges varied for a particular item, the distribution of that item would be very narrow and within one category. The scale value would be the mid-point of that category and the Q-value would be at its minimum. As an item tends to give different meanings to different judges and as the judges' evaluations of the meanings vary, the distribution of ratings for the item spreads into a number of categories. The scale value of the item is the point about which the distribution is centered. The Q-value increases with the spread of the distribution. The distribution of an ambiguous statement tends to be bi-modal, giving a large quartile deviation. Thus, the Q-value becomes a criterion of ambiguity or clarity of meaning.

In the past, scale makers have used this criterion of ambiguity in a general manner; selecting for the final scale those items with the lower Q-values without establishing a tolerable maximum. Thurstone and Chave permitted the Q-value to exceed 2.0 while in the Remmers [5] studies the value of some of the items exceeded 3.0, on an eleven-point scale. For the present study the maximum limit of Q-value was arbitrarily set at 1.1. However, since the investigators encountered the same difficulty faced by most scale makers in that there were few satisfactory items fallir.g in the mid-scale range, two items, numbers 30 and 31 of the final form, with the Q-values

[4] Odell, C. W. *Statistical Methods in Education.* New York: D. Appleton-Century Company, 1935. pp. 80, 106, 117.

[5] Remmers, H. H. (Ed.). *Studies in Higher Education XXVI. Studies in Attitudes.* Bulletin of Purdue University. Lafayette, Indiana: Purdue University, December, 1934.

of 1.5 and 1.7 respectively were appended to the scale. The administration of the scale may show that it is advisable to eliminate these two items.

After the results from the rating of the items had been summarized and the scale and Q-values calculated, thirty-one items were selected from the 150. These were prepared in the final form of the scale. Selection of items for this final scale was based upon the following criteria:

1. The Q-value for any item should not exceed 1.1, but for exception cited above.
2. Both the upper and the lower range of the scale should be represented equally well.
3. A scale value should be represented by one item only.
4. Where a choice is to be made between two items of the same scale value the one with the lower Q-value should be used.

An approximate estimate of the reliability of the scale values was obtained as follows: The mean Q-value of the thirty-one items is .796. The standard deviation of the distribution of scale values is therefore,

$$\sigma \text{ dist.} = \frac{Q}{0.67} = \frac{.796}{0.67}, \text{ or } 1.188 \text{ scale units.}$$

The scale value of an opinion is the median of its distribution on the subjective scale. Hence, the probable error of the scale value is

$$\text{P.E. med.} = .8453 \frac{\sigma \text{ dist.}}{\sqrt{n}} = .8453 \frac{1.118}{\sqrt{12}}, \text{ or } .29 \text{ scale units}$$

According to Garrett [6] the chances are fifty in one hundred that the true scale value is within .29 scale units from the value obtained by the use of this scale. It is practically certain that the obtained value is not more than four times the probable error, $4 \times .29$ or 1.16 scale units, from the true value. As an illustration, if a class were to obtain a mean score of 5.0 on the scale, the chances would be equal that the true mean score lay between 4.71 and 5.29 or one could safely say that the true mean score was not more than 6.16 or less than 3.84.

With a slightly larger mean Q-value and using 300 raters, Thurstone and Chave obtained a probable error of 0.06 scale

[6] Garrett, H. E. *Statistics in Psychology and Education.* New York: Longmans, Green and Co., 1937.

TABLE I

THE FINAL LIST OF ITEMS IN ORDER OF SCALE VALUE WITH THE Q-VALUES AND THE ORIGINAL ITEM NUMBERS

Item No.	Statement	Scale Value	Q Value
1	2	3	4
23	Very few things that occur really have any causes at all.	.6	.3
99	If a new car were to be given away to holder of the lucky number, I would choose my number very carefully.	.8	.6
40	Things that take place do not always need to have any causes—they may just happen.	1.0	.6
24	Cigarettes used by famous athletes and sportsmen must be better for one's health than other brands of cigarettes.	1.2	.6
97	A brand of breakfast food advertised in most newspapers and over the radio must be better than brands that are not so well known.	1.5	.5
48	If you look at a person's back long enough you can cause him to turn around.	1.7	.6
42	While one squirrel was teasing a pair of birds, its mate went up to the nest and ate all of the eggs. These squirrels must have planned this trick.	2.0	.7
94	Beauty and brains seldom go together.	2.3	.9
122	A dishonest person cannot look you in the eye.	2.5	1.1

TABLE I—Continued

Item No.	Statement	Scale Value	Q Value
1	2	3	4
66	Since fat people laugh more than slender people, thin persons should laugh more often if they wish to gain weight.	2.6	.4
81	By thinking about a thing hard enough it is possible to make someone else think about the same thing.	3.0	1.00
72	A person's face reveals his character, either good or bad.	3.3	1.0
112	People are always punished for the wrongs they do even if no one finds out about them.	3.7	.7
12	Our teeth will remain in good condition if we brush them twice a day.	3.8	1.0
138	The facial appearance of ordinary crooks reveals their character but some of the smartest crooks are able to hide their true character.	4.0	.9
133	Sometimes I believe that there is such a thing as good or bad luck and at other times I doubt it.	4.2	1.1
145	Most of man's misfortunes are caused by things over which he has no control.	4.4	.6
137	Playing checkers or chess helps to develop one's powers of concentration.	4.8	.8
75	It is never safe to judge people by their appearance.	5.0	.8
9	A high school boy with pimples on his face will be more popular if he gets rid of the pimples.	5.3	1.7
149	If one were planning to make an ordinary trip he should not be bothered by "hunches" as to dangers.	5.8	1.
127	Weather forecasts given by calendars and almanacs are absolutely worthless.	6.0	1.5
86	All charms and good luck tokens are useless.	6.6	.8
36	Very few things ever happen without some causes.	7.0	.9
132	One day the maid broke a large hall mirror. Shortly after that she and her family met with a number of misfortunes. Breaking the mirror had nothing to do with the misfortunes.	7.2	.9
118	A man plays a number game, choosing a different number each time. He would have just as good a chance to win if he always chose the same number.	7.3	1.1
20	A man is stronger when he is angry or under other emotional strain.	7.5	.9
78	All things that people do, even insane people, have natural causes.	8.0	.6
74	The forces of nature act in an orderly manner.	8.2	.5
28	There must be some cause for everything that ever has or ever will happen.	8.3	.3
79	There is nothing so sacred that well trained men should not be allowed to investigate and try to explain it.	8.4	.3

units. If 300 raters had been used in this study a similarly small probable error could have been expected. Since twelve experts in the field of science education were used in the present investigation one may hypothesize, however without statistical support, that the scale is more reliable than is indicated above.

SCORING THE SCALE

The distribution of the values of the scale items is indicated on the linear scale below.

0 1 2 3 4 5 6 7 8 9

In this scale the extreme left end is given a zero value and the right end a value of

nine, representing the highest degree of the attitude. Each mark along the scale line represents the degree of the attitude possessed by any individual accepting each of the opinionated statements. Any one student checking through the scale will probably check a few statements and these will tend to be grouped in one portion of the scale. The score of an individual is found by averaging the scale values on only those items which he checks as acceptable to him.

By way of illustration, if a pupil checks only items one, five, ten, seventeen, and twenty-two with the scale values 2.5, 2.0, 3.7, 3.0, and 2.5 the average value would be 2.74. This pupil would in the opinion of these twelve experts possess the attitude "conviction of basic cause and effect" to the degree of 2.74 upon a scale with a range from 0 to 9 with respect to the particular items that appear in this scale. The scale and key follows:

AN EXPERIMENTAL SCALE

What is your opinion?

Name.. Age.......... Sex..........

Class............ Teacher.............................. School..........

Please check the courses which you have taken:

......Gen. Science ......Chemistry

......Adv. Science ......Biology

......Physics ......College science courses

This is not a true-false test. There is no list of right answers to be used in correcting your paper. It is your opportunity to express your own opinion, what you believe, about some problems that are often discussed and argued. These are statements with which you may or may not agree. Well educated people do not agree on many of them. Please read each carefully.

If you agree with the statement or if it states your opinion for the particular situation mark it as below:

Example: (Most, but perhaps not all, people will agree to the following statement.)

...✓...1. Growing children need more sleep than do adults.

If you do not agree with the statement or if it does not express your opinion or belief for the particular situation make no mark at all.

Example: (Very few, but perhaps some, people would agree to the following statement.)

........2. Man should not eat meat.

If you cannot understand the statement or if you cannot make up your mind about it make no mark at all.

........3. Embryologists find evidences which prove conclusively that ontogeny recapitulates phylogeny.

MARK ONLY THOSE STATEMENTS WITH WHICH YOU AGREE

Remember, this is no test. Mark only those statements that you really believe.

...... 1. Beauty and brains seldom go together.
...... 2. One day the maid broke a large hall mirror. Shortly after that she and her family met with a number of misfortunes. Breaking the mirror had nothing to do with the misfortunes.
...... 3. Very few things that occur really have any causes at all.
...... 4. A man is stronger when he is angry or under other emotional strain.
...... 5. While one squirrel was teasing a pair of birds, its mate went up to the nest and ate all of the eggs. These squirrels must have planned this trick.
...... 6. There must be some cause, or causes, for everything that ever has or ever will happen.
...... 7. If a new car were to be given away to the holder of the lucky number, I would choose my number very carefully.
...... 8. A brand of breakfast food advertised in most newspapers and over the radio must be better than brands that are not so well known.
...... 9. All things that people do, even insane people, have natural causes.
......10. People are always punished for the wrongs they do, even if no one finds out about them.
......11. The facial appearance of ordinary crooks reveals their character but some of the smartest crooks are able to hide their true character.
......12. Most of man's misfortunes are caused by things over which he has no control.
......13. If you look at a person's back long enough you can cause him to turn around.
......14. Since fat people laugh more than slender people, thin persons should laugh more often if they wish to gain weight.
......15. If one were planning to make an ordinary trip, he should not be bothered by "hunches" as to dangers.
......16. There is nothing so sacred that well-trained men should not be allowed to investigate and try to explain it.
......17. By thinking about a thing hard enough it is possible to make someone else think about the same thing.
......18. Sometimes I believe that there is such a thing as good or bad luck and at other times I doubt it.

......19. A person's face reveals his character, either good or bad.
......20. The forces of nature act in an orderly manner.
......21. Our teeth will remain in good condition if we brush them twice a day.
......22. A dishonest person cannot look you in the eye.
......23. Cigarettes used by famous athletes and sportsmen must be better for one's health than other brands of cigarettes.
......24. All charms and good luck tokens are useless.
......25. Things that take place do not always need to have any causes—they may just happen.
......26. A man plays a number game, choosing a different number each time. He would have just as good a chance to win if he always chose the same number.
......27. Very few things ever happen without some cause.
......28. It is never safe to judge people by their appearance.
......29. Playing checkers or chess helps to develop one's powers of concentration.
......30. Weather forecasts given by calendars and almanacs are absolutely worthless.
......31. A high school boy with some pimples on his face will be more popular if he gets rid of the pimples.

Statement No. in Scale	Scale Value
1	2
1	2.5
2	7.2
3	.6
4	7.5
5	2.0
6	8.3
7	.8
8	1.5
9	8.0
10	3.7
11	4.0
12	4.4
13	1.7
14	2.6
15	5.8
16	8.4
17	3.0
18	4.2
19	3.3
20	8.2
21	3.8
22	2.5
23	1.2
24	6.6
25	1.0
26	7.3
27	7.0
28	5.0
29	4.8
30	6.0
31	5.3

FIGURE 1. Key for the Scale for Determination of Scientific Attitude of Conviction of Basic Cause and Effect Relationships.

A scale constructed by the technique used has the following advantages:

1. It is easily administered.

2. The scale may be determined objectively.

3. The possibility of misinterpretation on the part of the subjects is reduced to a minimum.

4. The scores obtained have statistical significance.

A number of studies have shown that it is possible to construct scales for measuring attitudes toward specific things. Studies reported by Remmers demonstrate that it is possible to construct *generalized scales* measuring attitudes toward any specified thing from a larger classification. The present study is a second step in the effort to construct a scale for measuring *generalized attitudes* in science.

The next steps imply:

1. That this scale be administered and standard norms be established.

2. That other forms of the scale be constructed.

3. That forms for other scientific attitudes be prepared and norms established.

4. That if other scales are prepared particular care be exercised in the preparation of the original list of statements to insure adequate distribution of items in the mid-scale area.

SCIENCE EDUCATION IN THE BUSINESS CURRICULUM

M. Winokur
College of the City of New York

"This is a business man's civilization" [1] is a catchward that is matched in currency only by the expression "We live in an age of science." [2] The prevalence of these two notions and their frequent association are alone, perhaps, indicative of the need that the business man has for some science training.

Much has been written about the controlling influence that business has on American life. "The business man with us finds himself the dominant power in the life of the nation and almost alone in his control of the direction of its entire life, economic, social, intellectual, religious, and political." [1]

It is likewise evident that the whole cultural life of the people is profoundly influenced by the material elements of the environment. This magnificent material base of our culture has been developed by the application of discovery and invention to a rich natural heritage. That our civilization rests upon science is so patent that it is unnecessary to enumerate, were it possible, the specific contributions of each of the sciences to our daily life.

What need then has the prospective business man for studying science as such? One might, of course, indicate that from the narrow materialistic viewpoint the business man ought to be acquainted with the effects of science on everyday life so as best to be able to take advantage of industrial opportunities. Science is the handmaiden of business in the discovery and exploitation of resources whether natural, commercial, or human. The alert business man must keep in touch with technical advance. However, he cannot, in the course of his education, obtain all of the details of science. He must in the last analysis rely upon the advice of specialists. Nevertheless in his education he can get an adequate scientific base for understanding the recommendations of the technicians, and for comprehending the influence of science on the trends of industrial development.[3]

However, education in science has a far greater significance than as merely a money-making aid. Since the business man exerts such a controlling influence on the lives of his fellow citizens, he has especial need for an adequate interpretative education. He, as the leading citizen, must understand the dynamic nature of our material culture as conditioned by the advance of science, and must sense and meet the problem of society arising from a changing technology.[4] "The growing number of inventions and scientific discoveries has brought broad problems of morals, of education, of law, of leisure time, of unemployment, of speed, of uniformity and differentiation, and its continuation will create more such problems." [5] To comprehend these problems and to meet them in an understanding and intelligent fashion, the business man requires some acquaintance with the science that has brought them into being.

[1] Adams, James Truslow. *Epic of America.* Boston: Little, Brown and Company, 1931. 433 p.

[2] Russell, Bertrand. *The Scientific Outlook.* New York: W. W. Norton and Company, 1931. 277 p.

[3] Lowell, Lawrence, as quoted by Carl Holliday. "Died a Specialist." *Journal of Education* 118: 299–301; June, 1935.

[4] President's Research Committee on Social Trends. *Recent Social Trends in the United States.* New York: McGraw-Hill Book Company, 1934. 1052 p.

[5] Greenan, John T. *American Civilization Today.* New York: McGraw-Hill Book Company, 1934. 152 p.

In short, the business man needs education in science not only to be a better business man, but more important, in order to live a fuller and more understanding life in his role as the country's leading citizen.

From the latter, and more significant aspect, the prime function of science instruction in the curriculum of the collegiate school of business is to contribute to the broad base of general education.

The question then arises as to how much and what kind of science instruction is adequate and desirable for general education. On the one hand, the specialists in each science feel that their science should be learned as completely and as fully as possible or not at all. While on the other, the average educated citizen feels that he ought to know enough about each science and science in general to understand what it deals with and how it affects his life.

Until recently, the specialists have been in control of the education offered in the colleges. The programs of study they formulated as a consequence were intended to train specialists and producers of science. The student in search of a liberal education had to be satisfied with a small and detailed segment of some one field of science or do without any science education at all.[7, 8] There was no way for him to obtain an adequate conception of the general principles of science and an appreciation of their significance in his daily life.

It was this predicament of the general student which motivated educators to formulate survey courses in science designed to meet the everyday needs of the general student rather than the technical needs of prospective science specialists.

The conflicting demands of general education and the training of specialists is not limited to the field of science. The entire realm of higher education is confronted with the need for curricular reorganization. Factual knowledge of all kinds is accumulating too fast for all of it to be presented, as facts, in the regular introductory courses. Viewpoints must be acquired rather than isolated facts. These viewpoints must be so integrated that they will enable young people to adjust themselves to a changing environment.[9]

The general burden of complaint is to the effect that the education of the liberal arts college is no longer liberal. The interest in ideas has given way to our present emphasis on facts. The fault is placed upon the extreme subdivision of the curriculum. Such specialization and subdivision of labor, while necessary for advancing the frontiers of knowledge, is not conducive to the development of a unified perspective or point of view.[10, 11, 12, 13, 14, 15, 16] "The attempt is now being made to promote integration through the organization of survey or orientation courses of general

[6] Huxley, Julian. *Scientific Research and Social Needs.* London: Watts and Company, 1934. 287 p.

[7] Spencer, William H. "The Place of Natural Sciences in the Curriculum of a Collegiate School of Business." *Journal of Business of the University of Chicago,* part 5: 52–55; October, 1932.

[8] Jean, F., Herman, F. L., Harrah, E. C., Powers, S. R. *Introductory Courses in Science for Colleges.* Boston: Ginn and Company, 1934. 589 p.

[9] Holliday, Carl. "Died a Specialist." *Journal of Education* 118: 299–301; June, 1935.

[10] Hibbard, Addison. "A Correlation Program at Northwestern." *Journal of Higher Education* 4: 24–26; January, 1933.

[11] Allison, Tempe. "What of the Survey Courses." *National Association of Deans of Women. Yearbook,* 158–161; 1935.

[12] Frank, Glen. "The Experimental College." *Journal of Higher Education* 1: 305–313; June, 1930.

[13] Meiklejohn, Alexander. "The Experimental College." *Bulletin of the University of Wisconsin* 10–23; March, 1928.

[14] Jacob, Peyton. "A Reorientation of the Arts College." *Journal of Higher Education* 4: 407–412; November, 1933.

[15] Bode, Boyd H. "Aims in College Teaching." *Journal of Higher Education* 3: 475–480; March, 1933.

[16] Bode, Boyd, H. "The Answer." *Journal of Higher Education* 4: 168–170; April, 1933.

character within the main fields of knowledge." [17]

Most college courses are composed of integrated materials from the realm of human experiences; the survey courses represent a broader inclusion than did the older departmentalized courses.[18, 19, 20, 21, 22] Taken together the survey courses constitute a broad base of general education. Examples of general education programs employing the survey course plan are manifold.[23, 24, 25, 26] They commonly include physical science, biological science, the humanities, and social science. Physical science deals with man's understanding of and adjustment of man to his physical surroundings. Biological science is concerned with the nature of life, especially as it manifests itself in man. The humanities present man's cultural achievements. And social science considers the modes of group living by means of which man has sought to advance humanity.

[17] Harbeson, John W. "The Pasadena Reorganization." *Institute for Administrative Officers of Higher Institutions. Proceedings:* 132–145; 1934.

[18] Kelly, F. J. "Liberalizing College Education." *American Association of Collegiate Registrars. Proceedings:* 342–361; 1932.

[19] McDowell, E. E. "A General Humanities Course." *Journal of Higher Education* 7: 16–22; January, 1935.

[20] Powers, S. R. "Background for Science for the Education Teachers." *National Society of College Teachers of Education. Yearbook:* 9–21; 1937.

[21] Allison, Tempe. "What of the Survey Courses." *National Association of Deans of Women. Yearbook:* 158–161; 1935.

[22] Johnston, J. B. "Higher Liberal Education." *School and Society* 44: 33–42; June, 1936.

[23] Hutchins, Robert M. "The Higher Learning in America." *Journal of Higher Education* 4: 1–8; January, 1933.

[24] Orr, M. L. "Curriculum Revision at Alabama College." *Journal of Higher Education* 6: 179–184; April, 1935.

[25] Freeman, Ellis. "Two Types of Divisional Courses in the Natural Sciences." *Journal of Higher Education* 7: 308–312; June, 1936.

[26] Bewkes, Eugene Garrett. "The Colgate Plan." *Institute for Administrative Officers of Higher Institutions. Proceedings:* 107–118; 1934.

Whatever the particular organization at various institutions, the general objectives of the survey course programs are fundamentally the same. The aim is to explore broad fields of human knowledge and activity with the view to attaining general concepts interpreting modern life and serving as a background for intelligent social participation.[27, 28, 29, 30, 31]

To attain the objective of an integrated perspective the survey course itself must evidence an inherent unity despite the fact that it deals with material from various fields. And further, to be truly educational it must contain sufficient subject matter to lead to true understanding and appreciation.

With regard to the survey courses in science, the general education movement has been only one of the causative factors. There has been simmering for some time a resentment against the aloofness of science. The scientists absorbed in their abstruse researches have assumed in the lay mind the aura of a new mysterious cult. James Harvey Robinson in his "Humanizing of Knowledge" [32] makes an appeal to the scientists to step out of their cloisters and mingle with the rest of humanity. He feels that the methods that have been so fruitful within the sphere of natural phenomena could be of service in all human endeavor.

[27] McDowell, E. E. "A General Humanities Course." *Journal of Higher Education* 7: 16–22; January, 1935.

[28] McClintic, Joseph O. "Relation of the Survey and Specialized Courses in Junior College Social Studies." *California Journal of Secondary Education* 10: 435–438; October, 1935.

[29] Humphreys, J. Anthony. "General Education and Specialization." *Journal of Higher Education* 7: 296–300; June, 1936.

[30] Miller, J. C. "Orienting the Freshman." *Junior College Journal* 4: 464–471; May, 1934.

[31] Powers, S. R. "Background for Science for the Education of Teachers." *National Society of College Teachers of Education. Yearbook:* 9–21; 1937.

[32] Robinson, James Harvey. *The Humanizing of Knowledge.* New York: Harper and Brothers, 1926. 93 p.

The difficulty has been that the colleges and universities have been devoting their efforts to the training of science specialists.[33, 34] That these efforts have succeeded in advancing the frontiers of science and in fostering material expansion is beyond question. But, scientists could be of even greater service to mankind than by merely accumulating ever more science knowledge and exposing society to its consequences. As has been increasingly realized, the method of science is as important, or more so, than the results. Effective education should make the scientific method and attitude of wider acceptance. Furthermore the intellectual consequences of science, and not only the material ones, should be more widely disseminated. An adequate liberal education should include the significant ideas of science needed for interpreting our modern world. Finally, with the increasing amount of leisure, scientific pursuits may well play a larger part in our cultural life. All this has been termed "consumer" science [35] as opposed to the "producer" science of the specialist. The universities and colleges have been adequately training producers of science but have largely been neglecting the consumers of science.

To remedy this defect, to attain some public understanding of their sciences, eminent scientists have begun to write for lay consumption. The movement started abroad, but the United States is now witnessing much of such activity in the constant flow of authoritative popular books in all phases of science. In addition, such organizations as *Science Service* keep the public informed of the most recent developments in science.

Meanwhile, in the schools, the exponents of general education are beginning to have their view of science as a part of a cultural and interpretative education more widely accepted.

The disparity between the material advance of science and the lack of public understanding of it has been felt in other countries as well. In England, educational forums have been held especially devoted to the problem of: "The Failure of Modern Science Teaching to Develop an Adequate Cultural Background to Life." [36] The remedy advocated was ". . . some course in really general science as one of the universal bases of education." [36]

In the United States this remedy is already being applied extensively [37] in the form of the new survey courses in natural science. These courses are being formulated to give students that broad view of the fields of natural science which should be part of a well-rounded liberal education. The aim is to present a comprehensive view of the nature of man and his environment as seen from the standpoint of natural science to the end that the student might attain a rational outlook on life and the universe.

However, the integration of the sciences for general education is not entirely a novel idea. As far back as 1846 in a volume on "University Education," Charles Dubeny, of the University of Oxford, vouchsafed some "Brief Remarks on the Correlation of the Natural Sciences."

The rapid rate at which generalized science courses are being incorporated into the curricula of the colleges throughout the United States is indicative of the fact that they fill a long felt need. A study in 1935

[33] Bruce, G. V. "Humanized Science." *Education* 57: 120–122; October, 1936.

[34] Isenbarger, J. "Biological Science in the Chicago Junior Colleges." *School Science and Mathematics* 35: 73–77; January, 1936

[35] Downing, Elliot R. *An Introduction to the Teaching of Science.* Chicago: University of Chicago Press, 1934. 258 p.

[36] Huxley, Julian S. "Failure of Modern Science Teaching to Develop an Adequate Cultural Background to Life." *Conference of Educational Association. Report:* 257–262; 1934.

[37] Winokur, M. "Survey of Generalized Science Courses in Institutions of Higher Education." *Science Education* 20: 132–140; October, 1936.

showed that ". . . the list of institutions offering survey courses in science contained 44 liberal arts colleges and universities, 35 teachers colleges, 11 normal schools, and 14 junior colleges.[37]

The chief principle recognized in the construction of science survey courses is that of developing a unified concept of nature. To do this the old departmental categories have to be abandoned. The inclusion of subject matter for its own sake is no longer justified. Only that material is selected which contributes to an integrated view of science and society.[38, 39]

In actual administration the survey course in natural science is usually divided into two parts, physical science and biological science. The physical science part usually includes material drawn from physics, chemistry, astronomy, geology, and geography, but these categories as such are eliminated. The aim is to attain a unified conception of the physical universe with especial attention to man's immediate environment. In the biological science portion of the survey course the major goal is an understanding of the nature of the life processes with particular emphasis on place of man in the realm of living things.[40, 41, 42]

It is beginning to be felt that general education in science for the business student is best provided for in the science survey courses. Through these courses he can most readily obtain an appreciation of the spirit and content of science and of its contribution to life in modern society.

[38] Eckles, Charles F. "Principles which Govern the Selection of Materials and Methods for the Physical Science Survey Course." *California Journal of Secondary Education* 10: 243–246; March, 1935.

[39] Newman, H. H. "An Orientation Course." *Journal of Higher Education* 2: 121–126; March, 1931.

[40] Matherly, Walter J. "Comprehensive Courses." *Journal of Higher Education* 7: 124–133; March, 1936.

[41] Anonymous. "Natural Science Courses at the George Washington University." *School and Society* 40: 380 p.; September, 1934.

[42] Hurd, A. W. "Analysis of Some Professionalized Subject-matter Courses in Science in Teacher-Training Institutions." *Science Education* 17: 277–280; December, 1933.

CURRICULUM RELATIONS INVOLVED IN THE CONSERVATION PROGRAM OF THE UNITED STATES BIOLOGICAL SURVEY

IDA C. WIED

North Shore Country Day School, Winnetka, Illinois

THE PROBLEM

The principles or matters to be included in the biological courses of study of secondary schools have been subject to much controversy and change during the past two decades. Programs of work have been revised and reorganized to fit the changing needs and interests.[1] Many studies have been made in surveying the field of applications of these principles, the results of which might well be used as possible guides toward a more intelligent approach to the selection of material pertinent to the subject. Investigations of these studies seem to indicate a tendency toward seeking to find the functional side of the subject, *i.e.*, wherein and to what extent the individual matters are being applied in everyday living.

This particular study was made to determine the matters emphasized in a federal

[1] Wilbur, L. Beauchamp. *Instruction in Science*. Bulletin, 1932, No. 17. National Survey of Secondary Education, Monograph 22. Washington: Government Printing Office, 1933.

government project and to consider their relationship to the content of a course in secondary school biology. An activity of the federal government which comes very near to this field is the conservation program of the United States Biological Survey, and it was therefore chosen as the basis for this work. The program, procedures and results of this bureau's work are outlined and discussed in their publications issued at frequent intervals. Through this material it is possible to obtain a fairly complete statement of the accomplishments of this organization up to the present time. The publications used for analysis were *Wildlife and Research and Management Leaflets, North American Fauna, Biological Survey Bulletins, Farmers' Bulletins, Biological Survey Circulars, Department of Agriculture Yearbooks, Wildlife Reviews, Technical Bulletins, Service and Regulatory Announcements, Service Monographs, Miscellaneous Publications, National Research Commissions Report as of June, 1937,* and *Recent Social Trends.*

The principles selected as being basic in this field were chosen after a careful consideration of several reports of committees on curriculums, textbooks in current use, and previous studies in the field.

The conservation program referred to here will necessarily be limited to plant and animal life. A twofold purpose is involved in this study, namely: (1) to determine what biological principles are emphasized in our public conservation policy and (2) to find concrete illustrations of principles taught and accepted as being of importance in a high-school biology program. That the work of the Biological Survey may be clearly understood at the outset, a section follows, outlining the historical development of this bureau from its inception up to the present time.

THE EVOLUTION OF OUR CONSERVATION POLICY

That the social structure of the United States is becoming more complex and highly organized is a widely accepted fact. From a country in which it was possible for anyone to come and take from it what he wished, it has advanced to a point where it is necessary to regulate to a high degree the resources available, so that the highest good may come to all rather than to an aggressive few.

The government, assisted by public opinion acting through private organizations, has been the ruling factor in attaining this needed regulation. The ruthless practices of the pioneer who slashed through the frontiers wasting as much as he took have had to be changed to regulation in the extreme. Natural resources such as coal, timber, oil and minerals have fallen under this regulation. Now, with the attention focused on leisure and the need for recreational facilities becoming more acute, a demand for conservation of our plant and animal life is being felt.

First organized efforts at conservation.—As early as the beginning of the nineteenth century, sportsmen's groups were organizing to improve the conditions of hunting and fishing. In 1898 the New York Zoological Society and the League of American Sportsmen had one thousand members and had become a real power in conservation. The Audubon Societies, American Game and Protection Association, and the Isaak Walton League were successively organized. All of these organizations not only improved conditions of hunting and fishing and enacted better game laws, but they also assisted in the enforcement of them.

The American Ornithological Union, first known as the Nuttall Club of Cambridge, was formally organized in 1883. It carried on studies of faunal areas, bird migration and the problem of the English sparrow. Their work was a phenomenal success and through their influence government wild life work was begun. In 1886 the Division of Economic Ornithology and Mammalogy was instituted, which in 1887 became the Division of Biological

Survey. In 1905 the Division became the Bureau of Biological Survey under the Department of Agriculture. The early emphasis was principally economic, the investigations involving food habits, migrations and relations to agriculture, horticulture and forestry. Biological explorations to determine geographic distribution, with a leaning toward the purely academic side, followed. However, the objections to this approach were effective in returning the program to a more practical phase in which economic biology based upon scientific research was the rule. This was a natural outgrowth of the rise of agriculture and a need for protection of crops from uncontrolled and noxious forms of life. Coincident with the expressions of this attitude was the demand that game be conserved, since the public had come to realize finally that this resource was not inexhaustible.[2]

SUMMARY OF THE WORK OF THE SURVEY

At present the United States Biological Society may be considered a "governmental bureau of the first rank, handling affairs of great scientific, educational, social and above all economic importance throughout the United States and outlying possessions." Along with this development of the Bureau itself has also come an evolution of a public attitude without which the work of the Survey could not go on. To quote: "Through three centuries of varying stages of free and easy, every man for himselfism that is inevitably a part of the vast operation of wilderness conquest, inasmuch as it is the very motive power of that operation, America moved by slow degrees relentlessly toward more centralized standards of wild life control as experience accumulated and necessity demanded; which is only another way of saying as economic exigency dictated." [3]

The foregoing brief statement of the activities of the Bureau of Biological Survey is enough to place it as

> a government agency that takes a leading part in American wild life and game conservation and in the repression and extermination of predatory and other undesirable species; that studies and investigates the life histories, the habits, the habitats, the range and the distribution . . . and the economic recreational and other values and significations of all American wild birds and animals; and that finally gives to the country the results and the conclusions arising out of its work and study in the form of numerous publications . . . This Bureau, though lacking an absolute monopoly in government natural history work by reason of the activities of such bureaus as these of Entomology, Plant Industry, Fisheries, Forest Service, National Park Service and Geological Survey, can claim to be that unit of the government most nearly possessing such a monopoly.[4]

Because of this near monopoly, the Biological Survey was chosen as the one which would best represent actual government work in the field of biology and would throw some light on the matters that should be stressed in bringing about an understanding of this very important government project. The extent to which certain biological principles are applied in the work of this Bureau might well serve as a guide in determining relative emphasis to be given to these principles in a biology course of study.

THE PRINCIPLES IDENTIFIED

In selecting the matters or elements to be included in a functional course in high-school biology, it is necessary to know "what are the important principles needed to solve problematic situations involving biology that arise in life." [5] Craig, in developing a course of study in science, has given three criteria for determining objectives to be sought:

[2] Jenks, Cameron. *The Bureau of Biological Survey, Its History, Activities and Organization.* Baltimore: The Johns Hopkins Press, 1929, p. 14–40.

[3] *Ibid.*, p. 82.

[4] *Ibid.*, p. 1.

[5] *A Program for Teaching Science*, p. 220. Thirty-first Yearbook of the National Society for the Study of Education, Part I. Bloomington: Public School Publishing Co., 1932.

1. Scientific conceptions that influence thoughts of the individual, *i.e.*, modify his thinking.
2. Goals for establishing health and safety in private and public life.
3. Principles, generalizations and hypotheses of science necessary to the interpretation of natural environment.[6]

A principle, by definition, is a fundamental truth; a comprehensive law or doctrine from which other laws are derived or on which others are founded. It is necessary to determine the fundamental truths underlying the various situations and phenomena which are common to the majority. Actually this has been done by several groups and individuals surveying different areas in this field.

Sources of Principles.—The items identified for this study were taken from eighteen different sources, including textbooks, courses of study, reports of committees on courses of study, a thesis covering the biological principles in popular books on the subject of biology, and the generalizations from the Thirty-first Yearbook of the National Society for the Study of Education.

The principles formulated in the Thirty-first Yearbook were used as a starting point inasmuch as they represent a bringing together of the thought on this subject up to the time of publication. The remaining sources were examined for principles and each checked against the original list. Any new significant items were likewise added to the list and checked against. In some cases it was difficult to determine the principle involved where texts were organized on the basis of a great number of small items or topics, or on the other hand into very broad units which might embrace a number of principles. After charting the occurrence of the individual principles, the frequency of use was noted and those rating highest in frequency were chosen as probably being most significant. Table 1 indicates the principles charted and their frequency of occurrence in the eighteen sources.

TABLE 1

OCCURRENCE OF PRINCIPLES IN EIGHTEEN SOURCES CHOSEN

Principle		Number of Sources Using Principle
I.	All life from previously existing life	18
II.	All organisms must be adapted to environment	17
III.	Food, oxygen, certain optimal conditions of temperature, moisture and light essential to life of most living things	16
IV.	More complex organisms derived from the simpler	15
V.	Protoplasm is the material of life. Increasing complexity accompanied by a division of labor	14
VI.	Energy cannot be created or destroyed	13
VII.	Organisms are irritable and respond to stimuli	13
VIII.	The cell is the structural and physiological unit	12
IX.	Animals and Plants are not distributed uniformly, but are found in definite zones and in local societies	11
X.	The ultimate source of energy is sunlight	10
XI.	Man can modify nature of plant and animal life through his knowledge of heredity	9
XII.	Micro-organisms are the cause of some diseases	8

BIOLOGICAL PRINCIPLES ILLUSTRATED BY CONSERVATION PROBLEMS

Reference has been made previously to the particular types of publications which were used for this study. Ninety-eight

[6] Gerald S. Craig. *Certain Techniques Used in Developing a Course of Study in Science for the Horace Mann Elementary School*, p. 73. Teachers College Contribution to Education, No. 276. New York: Teachers College, Columbia University, 1927.

pamphlets were reviewed in all, distributed as shown in Table 2.

TABLE II

DISTRIBUTION OF PAMPHLETS ANALYZED FOR PRINCIPLES

Type of Pamphlet Used	Number of Pamphlets Used
Wildlife Research and Management Leaflet	24
Farmers' Bulletin	22
Department of Agriculture Yearbooks (Reprints)	18
Biological Survey Circular	10
North American Fauna	8
Miscellaneous Publication	4
Technical Bulletin	3
Service Monographs No. 54	2
Service and Regulatory Announcement	2
Biological Survey Bulletin	3
Wildlife Review	1
National Research Committee Report	1

In addition to the listed pamphlets, Recent Social Trends [7] was consulted for the results of the investigation on Agricultural and Forest Lands as recorded by O. E. Baker; and Van Hise and Havemeyer's Conservation of Natural Resources furnished the material on the history of the conservations movement.[8]

[7] O. E. Baker. "Agriculture and Forest Lands." *Recent Social Trends* in the United States, pp. 90–122. Report of the President's Research Committee on Social Trends. New York: McGraw-Hill Book Co., Inc., 1933.

DISTRIBUTION OF BIOLOGICAL PRINCIPLES

A wide variation in emphasis.—It became evident in reading through the material and selecting the items which illustrated biological principles that certain of these principles were being applied much more frequently than were others. The distribution of these principles is indicated in Table 3.

Certain optimal conditions necessary to life.—As might be expected, Principle VII, which states "Food, oxygen, and certain optimal conditions of temperature, moisture and light are essential to the life of most living things" was referred to much more than any other single principle. Eighty-six and four-tenths per cent of the total number of items were based on this idea.

Organisms must be adjusted to their environment.—Principle IV, which states that all organisms must be adjusted to their environment in order to survive in their struggle for existence, was found to be important in that it was illustrated by eight per cent of the items checked. When one remembers that there is a continual struggle for existence on the part of all organisms

[8] Havemeyer, *op. cit.*

TABLE 3

FREQUENCY OF MENTION OF BIOLOGICAL PRINCIPLES

	Principle	Times Mentioned	Per Cent of Whole
I.	No energy can be created or destroyed	1	.02
II.	The sun is the source of all energy	3	.06
III.	Micro-organisms cause disease	82	1.84
IV.	Organisms must be adjusted to environment	355	7.99
V.	All life comes from life	25	.56
VI.	Organisms are found in definite zones	55	1.23
VII.	Food, Oxygen, Moisture, etc., necessary to life	3,771	84.90
VIII.	The cell is the structural unit	0	.00
IX.	More complex organisms evolve from simpler	36	.81
X.	Protoplasm the material of life	0	.00
XI.	Organisms are irritable and respond to stimuli	94	2.10
XII.	Man can modify organisms through knowledge of heredity	20	.45
	Total	4,442	99.96

and that the struggle involves one organism against another, it is apparent that the best adapted will of necessity survive. Man is concerned with the maintaining and protecting of the species he considers desirable and is therefore upsetting the natural balance of life. Much of the work of the Biological Survey is in the analyzing of these upset balances and suggesting remedies for the evils that result therefrom.

Policies of the past revised.—It was previously noted that the United States Biological Survey had functioned on the basis of economic ornithology, geographic distribution, and finally protection of game and desirable species and the repression of the undesirable. The more recent publications, *i.e.,* from 1934 up to the present, indicate that the emphasis now is on the ecological problem in its broadest sense.

Multiple use of forests.—The plan for multiple use of forests as contrasted with forests being grown for a timber crop only is expressed in seven instances. Gabrielson, in writing on Correlation of Forestry and Wildlife Management, states that one of the needs calls for "modification of present forestry management to correlate them with the needs of wild life. (a) Multiple use idea may be modified to extend it to recreational uses and therefore increase the game population. (b) Management for sustained yield, *i.e.,* forests as a crop may be used to advantage of animals." [9]

Reclaiming of marginal and submarginal lands.—Another side of the question referred to is the reclaiming of marginal and submarginal lands as areas for wild life. In the Yearbook for 1935 is this statement: "Conditions most favorable to wildlife are identical with these that reduce erosion and promote flood control and soil improvement by the conservation of water resources and production of heavy growths of vegetation for food and cover." [10]

Maintaining a balance of nature.—Both of the foregoing points might be considered as part of a larger concept, *i.e.,* maintaining a balance of nature. Natural methods are dependent upon the principle that the most fit survive and therefore when the numbers become too great, the weaker perish through lack of food or by falling prey to the natural enemy. Man's interference with this natural law has been disastrous in some cases. Purely artificial methods of trying to secure a balance of nature are by the outright destruction of the undesirable forms by poisoning, trapping or shooting; by encouraging the desirable by furnishing them with the conditions favorable to their existence, *i.e.,* sufficient food and shelter.

Uses of technical information.—The technical information collected by the Bureau of Biological Survey is used in determining matters of policy. In other words, "Wild life investigations are necessary as a basis for the intelligent carrying out of other activities. Habits of wild animals need to be known in the suppression and control of predatory and noxious animals. Genus and species determination is necessary in the study of the distribution of species. Life zone investigations reveal the factors that restrict habitats, and the study of diseases and parasites throws light on ways in which a more favorable environment may be secured for protected species. Field and laboratory studies are taken together to make their findings more reliable. The Bureau also cooperates with other agencies [11] in seeking to get a more complete picture of the whole flora-fauna relationship.

Practices not approved.—In its warfare

[9] Ira N. Gabrielson. The Correlation of Forestry and Wildlife Management, p. 1. United States Bureau of Biological Survey, Wildlife Research and Management Leaflet No. 37. Washington: Government Printing Office, 1936.

[10] "Wildlife Conservation." *Yearbook of Agriculture 1935*, p. 73. Washington: Government Printing Office, 1935.

[11] Forestry Service, Bureau of Plant Industry, Geological Survey, Coast and Geodetic Society, Bureau of Fisheries and Smithsonian Institute.

against obnoxious species, the Bureau disapproves of certain practices. According to W. L. McAtee, very few species require extensive control. To quote: "In making adjustments of wild-life relationships for economic reasons, we should do whatever is required, but no more." [12] The bounty system is not approved. The repression of an unprotected species is considered a matter of local concern and should be so handled. It has not been found wise to make a wholesale condemnation of a species which might menace its perpetuation.

Suggested changes for the future.—The biologists connected with the Bureau of Biological Survey are still not satisfied with things as they are and are making suggestions for still more improvement in the administration of good all around conservation. They should realize that to provide for utilization of surpluses, flexibility in the refuge idea is a requirement in the long-time program. Smaller areas from which surplus animals naturally drift into areas open to hunting, and movable refuges fitted into the growth cycle so that game population could be built up as food supplies increased, are suggested.[13] Control of grazing to prevent loss of forage for subsequent generations, a restoration of the balance of life between plants and animals, and a need for amplifying conservation laws to take care of unforeseen feeding ground problems as they arise are indicated. From the foregoing statements of policy based upon recent findings, it can be seen that the need for considering the whole problem of relationships involving plants, animals and physical surroundings, is recognized. Plants and animals, by virtue of the fact that they are living, are constantly changing and therefore regulations concerning them should likewise be changeable.

[12] W. L. McAtee. "Bird Species Not Menaced by Local Central Campaigns." *Yearbook of Agriculture 1934*, p. 140. Washington: Government Printing Office, 1934.

[13] Gabrielson, *op. cit.*, p. 7.

The analysis of the publications of the Bureau of Biological Survey relative to the conservation program seems to indicate that their plans and policies are pointed toward a consideration of their problems in their entirety, including any contributing or affecting conditions.

In classifying the individual items from the Bureau's publications on the basis of illustrating biological principles, the greatest emphasis was found to be upon the relation of organisms to certain physical conditions such as food, light, heat and moisture or to their environment in general, which would also include other organisms. Again, in articles written specifically to outline matters of policy a great deal of emphasis was laid upon the matter of relationships or organisms to each other and to their physical environment. In addition to these relationships, man's own relationship to his environment is important in that he can do much to control conditions which will result in a satisfactory conservation program.

It is significant that as early as 1920, the Committee for the Reorganization of Science in Secondary Schools recognized the importance of this broader view of biological understandings. They proposed at that time certain objectives which emphasize the points just referred to. They suggested that a course in secondary school science should present:

(1) The way in which each organism maintains its own life and the life of the species

(2) The interrelations between organisms and groups of organisms

(3) The constant dependence upon and interrelations of living things with the physical world about them

(4) The power of man to control the habits and relationships of plants and animals to serve his own ends.[14]

[14] *Reorganization of Science in the Secondary Schools.* A Report of the Commission on the Reorganization of Secondary Education appointed by the National Education Association, United States Bureau of Education, Bulletin 1920, No. 26. Washington: Government Printing Office, 1921.

It is apparent that the fourth objective cannot be realized without an adequate knowledge of the first three. The conservationist is constantly concerned with analyzing and interpreting conditions as he finds them so that he may wisely "control the relationships for the best common good of all." Here then lies a field rich in material with which to illustrate the biological principles which have been widely accepted as being important.

COMPARISON WITH OTHER STUDIES AND THE IMPLICATIONS

It was stated in a previous section that several studies have already been made to determine from other types of sources what principles received more emphasis in these particular fields. The results of some of these studies were compared with this particular survey to determine if there was any degree of correlation among them. The following table indicates emphasis on principles.

Granting that the aforementioned studies, including the present one, have determined the relative emphasis of biological principles as applied to special fields, it can be seen that the principles IV, VII, V and VI are apparently more important than the study of biological problems.

TABLE 4

RANKING OF PRINCIPLES BASED ON SIX STUDIES

Principles	Studies Compared			
	McAtee	Markland	Jones	Monto
I. Energy cannot be created	1	16	..	..
II. Sunlight source of energy	5	17	..	7
III. Micro-organisms-disease	3	6	..	1
IV. Adjust to environment	4	1	1	1
V. All life from life	2	14	3	1
VI. Zonation	6	4	6	7
VII. Food, Oxygen, etc., needed	8	15	2	1
VIII. Cell unit of structure	9	11	..	9
IX. More complex from simpler	7	2	..	15
X. Protoplasm basis of life	..	10	..	7
XI. Response to stimuli	..	..	..	4
XII. Applied heredity	..	..	3	..

TABLE 4 —Continued

Principles	Studies Compared		
	Hackett	This Study	Composite
I. Energy cannot be created	..	10	10
II. Sunlight source of energy	..	9	9
III. Micro-organisms-disease	..	4	8
IV. Adjust to environment	2	2	1
V. All life from life	6	7	3
VI. Zonation	13	5	4
VII. Food, Oxygen, etc., needed	1	1	2
VIII. Cell unit of structure	111	..	7
IX. More complex from simpler	4	6	5
X. Protoplasm basis of life	8	..	6
XI. Response to stimuli	10	3	12
XII. Applied heredity	..	8	11

CONCLUSIONS

The fact that the composite rating of six different studies places Principles IV and VII at the top of the list is some indication that biology in its broader scope is needed, rather than specialization in a narrower field. These principles emphasize the relationships of organisms to their organic and inorganic environment. Man's own relation to this environment is likewise important. The emphasis at present in secondary school curriculums is upon social problems and studies. Biology studied for its own sake or from a technical viewpoint alone would not contribute much to the solution of social problems. There is, however, a wide range of activities and subject matter which has a very direct bearing upon community, state and federal affairs. Federal government and local projects which are concerned with the care and conservation of natural resources require on the part of citizens an intelligent attitude based on understanding in order that the projects may permanently succeed. The understanding of these basic principles should be one of the major objectives of a biology course.

SCIENTIFIC KNOWLEDGE CONTRIBUTED BY GENERAL SCIENCE, BIOLOGY, CHEMISTRY, AND PHYSICS IN RELATION TO TEACHERS' GRADES

GEORGE TEMPEL MCKINNEY
Central High School and Junior College, Muskogee, Oklahoma

The purpose of this study was to determine whether marks given by teachers are an indication of general science knowledge, and whether the different science subjects, general science, biology, chemistry, and physics, contribute to the general scientific knowledge of three hundred seniors in Central High School, Muskogee, Oklahoma.

PROCEDURE

The test used for this study was the *Cooperative General Science Test,* Form N, formulated by O. E. Underhill and S. R. Powers, and published by the Cooperative Test Service of the American Council on Education, New York City. The immediate purpose of this test is to provide objective and reliable measures of individual differences in educational achievement. The test is so constructed and the norms and conversion tables established in a way to insure maximum comparability and meaningfulness for the results. The twelfth grade norm of this test is based on the score distribution of eighty schools and a total number of over seven thousand students in different size schools and different geographical areas, so the final tables are adequately representative of the performance of public secondary school students.

As the three hundred seniors of the graduating class of 1938 of Central High School, Muskogee, Oklahoma, constituted a group that had been offered all four science subjects, general science, biology, chemistry, physics, they were chosen for this study. For the purpose of providing a scientific basis for the study, the first step was to obtain the intelligence quotient for each individual. Each student in Central High School must take the *Otis Test of Mental Ability.* The range in intelligence quotient for this group was from the highest 147 to the lowest 73. The mean intelligence quotient was 109.44. Of the three hundred seniors, 4, or 10 per cent, were in the near genius class; 52, or 17 per cent, were very superior; 107, or 35 per cent, superior; 121, or 40 per cent, normal; 10, or 3.3 per cent, dull; and 6, or 2 per cent,

300 = 100%
4 = 10% ? ?
10 = 3.3%
6 = 2%

borderline. Of the three hundred seniors, 271 had attended Muskogee schools for the entire four-year period used for this study.

The next step was to divide the entire group into the following groups:

Group 1. Those students who made a mark of "A" in general science.
Group 2. Those students who made a mark of "B" in general science.
Group 3. Those students who made a mark of "C" in general science.
Group 4. Those students who made a mark of "D" in general science.
Group 5. Those students who did not take general science.

This division, into five separate groups according to grades received, was made for biology, chemistry, and physics respectively. According to the key to grading for Central High School, the numerical range for a grade of "A" is from 95 to 100, "B" from 89–94, "C" from 80–88, "D" from 75–79.

The findings of this study have been organized into eight correlations:

(1) Intelligence quotients of all 300 seniors and scores made on the test.
(2) School marks made in general science of the 258 seniors who studied general science and the scores made on the test.
(3) Intelligence quotients of the 250 seniors who studied general science and their school marks in general science.

The remaining correlations were made between those students who made respective grades of "A," "B," "C," and "D" in general science and their intelligence quotients.

In each of the five groups under the divisions of general science, biology, chemistry, and physics, a chart and a graph were constructed to show whether the seniors of each group were above or below the mean score of the standardized test.

A general table showed each senior's intelligence quotient, scaled score made on the test, and grades made in general science, biology, chemistry, and physics.

FINDINGS AND CONCLUSIONS

The coefficient of correlation between the intelligence quotients and the scores made on the test of the entire groups was .49. This is a fair correlation and shows that those students with higher intelligence quotients tended to make a higher score on the test.

In the correlation between the school marks made in general science and the scores made on the test of the 258 seniors who studied general science, the coefficient of correlation was .32. This shows that those students who had a higher mark in general science tended to make a higher score on the test.

The coefficient of correlation between the intelligence quotients and the school marks of the 258 seniors who studied general science was .38. This is a fair correlation and shows that those students who had a higher intelligence quotient tended to make a higher school mark in general science.

In correlating the intelligence quotients and test scores of the 13 students of group 1 (those students who made a school mark of "A" in general science) the coefficient of correlation was found to be .12. The coefficient of correlation of the 99 students who made "B" was .25. The coefficient in group 3 (those who made a mark of "C") was .26. The coefficient in group 4 (those who made a mark of "D") was .25. The coefficient of group 5 (those students who did not study general science) was .68.

In the first group, the coefficient was lower than that of the entire group, but the difference can possibly be accounted for in part by the fact that the group was small, and that the students with the highest intelligence quotients did not necessarily apply themselves, and therefore the higher grades were distributed. The second group shows that the correlation had some tendency to increase as it approached the average or "C" group. There is evidence to show that a student with a high intelligence in this

group would probably make a high score on the test. In the third group there was a slight increase in correlation but there was only a slight increase in the number of students. In a graph of this group, both the intelligence quotient curve and test score curve were fairly normal, showing a more even distribution. In group four, one finds that a student with an average intelligence quotient would have a better chance to make an average score on the test than would a student with a higher or lower intelligence quotient. In group five, it is interesting to note that this group had the highest correlation. This shows that the relationship between the intelligence quotients and the scores made by this group were closer than they were in any other group. It is to be expected that the student with the highest intelligence would normally make the highest grade on the test. This tendency has been prevalent throughout the general science group; however, it is outstanding in group five which is composed of those students who did not study general science. The graph of group five shows the intelligence quotients and test score curves to be fairly equal in distribution and they have more tendency to coincide than in any other graph of the general science group.

With the school marks as the determining factor, all five groups of the general science division were studied. The mean standard of the test was 57.1. In group 1, the mean score was 55.8 which was 1.3 points below the mean score of the test. Evidently the students who had received a grade of "A" in general science were given too high a grade and did not belong in group 1 or the course of study used did not emphasize the material of the test. In group 2, the students were 4.75 points below the mean score. In group 3, the range of scores was greater. Evidently the students knew as much of the material emphasized on the test as the students of groups 1 and 2. Theoretically, students in groups 1 and 2 should have fallen far above the mean score. In group 4, the low range was ten points higher than the low range of group 3. Evidently the students of this group had been under-estimated by their instructors. In group 5, there were a greater number of cases below the norm. This fact is indicative that the students required formal instruction to help them in gaining scientific knowledge.

With the school marks as the determining factor in all five groups of the biology division, the high mean score of group 1 was 60.6 and the high mean score of group 5 was 46.7. Group 1 was 3.5 points above the standard 57.1 and group 2 was 6.1 points above the standard, while all the other three were below. As 27 questions out of the 80 included in the standard test dealt directly with biology, it would be expected that students having studied biology, and especially having received a mark of "A" would be far above the norm of the test. Since four cases of group 2 fell below the norm of the test when all should have been well above, it is concluded that the teachers of biology graded too leniently, or the course of study was inadequate. In group 3, the teachers graded more accurately, as this group was only 3.5 points below the norm. It is apparent that the group approached more nearly the average "C" group of the standard. The "D" students of group 4 evidently attained more knowledge than the teachers estimated, as there were 5 cases less above the norm, and the range was 2 points higher on both the high and low scores than in group 3. Approximately 14 per cent of group 5 were on or above the norm of the test. This shows that, on the whole, the study of biology tended to raise the scores made on the test.

With the school marks as the determining factor in all five groups of the chemistry division, the high mean score of group 1 was 64.1 or 7 points above the standard, while the high mean score of group 5 was

53.1 or 5 points below the standard. Since 25 questions on the test dealt directly with chemistry it would be expected that the study of this course would affect the scores made on the test. In group 1, only 6 students out of the 9 were above the norm; therefore the teachers of this group graded too high as there were actually no "A" students as compared to the requirements of the test. In group 2, the scores were lower and the group as a whole was 2.6 points below the norm. In group 3, only 9 of the 61 people were above the norm. In order to have a fairly accurate "C" group, approximately 30 people should have been above the norm. As group 4 was 14.6 points below the norm and none was above, approximately 8 should have received a mark of "E" in comparison to the results of this test.

Approximately 12 per cent of the 152 students who did not study chemistry were above the norm. In comparing scores made in the "A" and "B" group, it is evident that the study of chemistry had some effect on the scores made on the test. The low score of groups 1 and 2 was 34 as compared to the low score of 11 for group 5.

With the school marks as the determining factor in all five groups of the physics groups, the high mean score of group 1 was 67.7 or 10.6 points above the standard while the high mean score of group 5 was 46.6 or 10.7 below the standard of the test. In group 1 all but one of the 12 students were above the norm. This is by far the best group, a grade of "A" in physics definitely aided in the scores made on the test. In comparison to the requirements of the test, however, these people were not "A" students. Twenty-nine questions dealt with physics, but the teachers of physics were grading too high even in this group, or the course of study was inadequate, or the test too complicated. Thirteen cases out of 15 in group 2 were above the norm, and possibly 3 or 4 could be considered "B" students in comparison to the test. Only 3 cases out of the 21 students who made a grade of "C" in physics were above the norm, and the mean score was 7.5 points below the norm. This group was definitely graded too high as there are 6 students in this group who were "D" or "E" students. In group 4, those who made a "D" mark in physics ranged above those who received a "C" mark. The students of group 4 had been graded too low for they are actually "C" students. Of the 240 students who did not study physics, approximately 9 per cent were above the norm of the test, but the mean was 10.7 points below. This definitely shows that the study of physics had much to do with the scores made on the test.

In conclusion it is to be noted that in each group according to the scores made on the test, the students were either to a great degree or to a small degree, out of their class; *e.g.*, those classed as "A" students in general science made scores on the test far below normal. In comparison of the grades the students received with the scores made on the standardized test, in practically every case, the students were either graded too high, or the course of study was inadequate, or the test was too complicated. To determine which of these was the cause would require a new study of an entirely different nature.

SCIENCE REQUIREMENTS IN MIDWEST TEACHERS COLLEGES

LEONARD A. FORD
State Teachers College, Mankato, Minnesota

A study of the curricula in the six Minnesota Teachers Colleges and fourteen other midwest teachers colleges has been made with a view to determine the preparation of prospective teachers in science. These colleges were located in fourteen midwestern states; their enrollment, objectives and curricula are quite similar. The requirements were then compared with the recommendations of well known authorities in science education.

The curriculum of a teachers college is generally divided into three classes; the two or four year curriculum for elementary teachers and a four year curriculum for secondary school teachers. The required courses in science are intended to provide a cultural background or a specific preparation in that field for the prospective teacher.

To keep the investigation within reasonable bounds, science refers to subject matter of biology, chemistry, and physics, its combinations and subdivisions. All of these colleges include these offerings in their science departments while a scattered few include health, mathematics, geography, teaching methods and other non-science subjects.

The characteristics of the science courses required in the two year elementary curriculum are indicated in Table I.

Several examples will illustrate the use of this table. The courses required of students who take the two year curriculum can be classified under the headings: nature study, biological and physical science. Nine teachers colleges in nine states are grouped together under the subheading (A) and six Minnesota teachers colleges under (B).

Two of the group of nine colleges require a course in nature study. The course varies from four to six quarter hours. The total number of hours of nature study required in these colleges divided by nine gives 1.1, the average number of quarter hours per college. This last figure indicates the trend in science requirements in the field of nature study in these colleges.

The table shows further that the total amount of science required in the two year curriculum in these colleges averages 10.2 hours. The Minnesota colleges require less, only six quarter hours with as little as four hours in some colleges.

A detailed study of the college bulletins shows that the requirements in the two year curriculum in Minnesota colleges include a preponderance of biological offerings in nature study, methods courses and general science; whereas survey courses in both biological and physical science with some laboratory are more common in other colleges.

TABLE I

SCIENCE REQUIREMENTS IN THE TWO YEAR ELEMENTARY CURRICULUM IN NINE SELECTED TEACHERS COLLEGES (A) AND SIX MINNESOTA TEACHERS COLLEGES (B)

	Nature Study		Biological Science		Physical Science		Total Science	
	A	B	A	B	A	B	A	B
Number of Colleges	2	3	5	2	5	3	9	6
Range (Quarter Hours)	4–6	4	3–6	4–8	3–6	4	4–18	4–12
Average (Quarter Hours)	1.1	2.0	2.8	2.0	2.6	2.0	10.2	6.0

TABLE II

SCIENCE REQUIREMENTS IN THE FOUR YEAR ELEMENTARY CURRICULUM IN FOURTEEN SELECTED TEACHERS COLLEGES (A) AND SIX MINNESOTA TEACHERS COLLEGES (B)

	Nature Study		Chemistry or Physics		Biology		Physical Science		Biological Science		Total Science	
	A	B	A	B	A	B	A	B	A	B	A	B
Number of Colleges	3	1	2	0	3	3	4	3	3	1	14	6
Range (Quarter Hours)	4–12	4	8–12	0	4–16	8–21	4–6	4	5–6	4	8–30	8–21
Average (Quarter Hours)	2.0	.7	1.4	0	2.3	6.8	1.5	2.3	1.1	.7	15.	15.5

Table II shows that students in the four year elementary curriculum have a wider range of requirements in the fields of science. Here, as in Table I, the biological field seems to dominate. Especially is this true in the Minnesota colleges.

The recommendations of authorities on the training of elementary teachers in the field of science are at great variance with the findings in this study. Davis [1] points out that a diversified group of authorities in the field of elementary science education recommend a wide subject matter experience in broad fields of science and as a maturing factor, specialization in one field of thought in science.

Watkins, Robertson and Haupt [2] state that the best training that could be offered by teacher training institutions for elementary school teachers in science at present would consist of a combination of professionalized science courses and some well selected courses in the special sciences.

[1] Davis, Warren M. "Preparation of Ohio Elementary Teachers in the Field of Science." *School Science and Mathematics* 40:238–243; March, 1940.

[2] Preliminary Report of the Committee of the National Association on the Training of Science Teachers. *Science Education* 22:283–293; November, 1938.

TABLE III

SCIENCE REQUIREMENTS FOR ALL STUDENTS IN THE FOUR YEAR SECONDARY CURRICULUM IN FOURTEEN SELECTED TEACHERS COLLEGES (A) AND SIX MINNESOTA TEACHERS COLLEGES (B)

	Chemistry or Physics		Biology		Physical Science		Biological Science		Electives		Total Science	
	A	B	A	B	A	B	A	B	A	B	A	B
Number of Colleges	2	0	3	3	3	2	1	1	11	2	14	6
Range (Quarter Hours)	8–12	0	8–12	8–13	4–12	4	5	4	8–30	8–12	8–24	8–13
Average (Quarter Hours)	1.4	0	2	5.5	1.5	1.3	.3	.7	13.2	3.3	14.0	10.8

Powers[3] suggests 28 semester or 42 quarter hours in science as a minimum for elementary teachers.

None of the twenty teachers colleges meet the requirements of these authorities on science education for elementary teachers. It is possible, however, for prospective teachers in some of the (A) colleges to include considerable work in science. A major in science is possible in four of these colleges in the four year elementary curriculum. The average requirement is only 15 hours in science with as little as 8 quarter hours in some colleges. In the latter, a student spends less than five per cent of his total college course in the science field.

The science requirement for all students in the four year secondary curriculum is given in Table III. The Minnesota Colleges require less science than the 14 other colleges. The choice of electives is less and science required is chiefly in the biological field.

The requirements for a student selecting a science major are given in skeleton form in Table IV. A study of the college bulletins shows that almost all colleges require work in biology, chemistry and physics, regardless of whether the major was in generalized science or in one field of specialization. The most notable difference in requirements for a science major in the (A) and (B) colleges was that the former required considerable work in the senior college level whereas the Minnesota colleges require little or nothing beyond the Freshman courses in science.

Authorities[2, 3, 4, 5] in the field of training of high school science teachers generally agree that half of the undergraduate preparation should be in science. Enough training should be completed in one field to enable the prospective teacher to do graduate work in his specialty. These recommendations apply to junior and senior high school science teachers.

Further examination of Table IV shows that not one of the twenty colleges comes up to these minimum standards. Instead of giving one-half of the undergraduate preparation to science, (A) colleges require a third and the Minnesota colleges less than a fourth of the preparation in science.

The total offerings in science, expressed in quarter hours, is given in Table V. This table shows that biology offerings predominate in all colleges. This is especially true in the Minnesota colleges, whose average total offerings are less than half that of the (A) colleges.

[3] Powers, S. R., Chairman. *Thirty-first Yearbook, Part I.* National Society for the Study of Education. Bloomington, Illinois: Public School Publishing Company, 1932. p. 325–344.

[4] Peet, Bert W. "The Training of High School Science Teachers with a Suggested Curriculum." *Science Education* 17:199–202; October, 1933.

[5] Watkins, Ralph K. "The Preparation of High School Science Teachers in Terms of the Market." *Science Education* 20:56–60; April, 1936.

TABLE IV

SCIENCE MAJOR REQUIREMENTS IN THE FOUR YEAR SECONDARY CURRICULUM OF FOURTEEN SELECTED TEACHERS COLLEGES (A) AND SIX MINNESOTA TEACHERS COLLEGES (B)

	Biology Major		General Science Major		Additional Science		Minimum Science for Major	
	A	B	A	B	A	B	A	B
Number of Colleges	14	3	3	3	14	5	14	5
Range (Quarter Hours)	24–56	8–40			12–48	4–32	48–84	36–48
Average (Quarter Hours)	38	26			27	19	63	42

TABLE V

TOTAL SCIENCE OFFERINGS IN THIRTEEN SELECTED TEACHERS COLLEGES (A) AND SIX MINNESOTA TEACHERS COLLEGES (B)

	Biology		Chemistry		Physics		Total Science	
	A	B	A	B	A	B	A	B
Number of Colleges	13	6	13	6	13	6	13	6
Range (Quarter Hours)	22–120	20–60	32–75	16–40	24–75	12–30	84–252	52–106
Average (Quarter Hours)	77	39	54	24	43	19	173	73

Why are the science requirements for teacher certification so low? Why are these requirements so far below the recommendations of the best authorities in science education?

An examination of the entire two and four year curricula for elementary teachers in the twenty teachers colleges discloses that almost the entire program has been laid out for the student. Nearly half of his work is essentially in non-subject matter fields such as education, psychology, social studies and professionalized subject matter. The remaining part of his program is divided between the subjects that he will teach; thus little time can be devoted to science.

The four year secondary curriculum shows similar characteristics, so that it is almost impossible for the prospective junior or senior high school teacher to obtain any degree of respectable scholarship in science.

Unless the educators in the field of science have a greater voice in making the curriculum, little improvement can be expected in increasing the science requirements in teacher education.

THE SCIENTIFIC ATTITUDE AS RELATED TO THE TEACHING OF GENERAL SCIENCE

J. WESLEY EBERHARD
Beaumont Union High School

AND

GEORGE W. HUNTER
Claremont Colleges

INTRODUCTION

In reading the educational literature on the methods used in working for the attainment of the scientific attitude and for reflective thinking at the secondary school level, one is impressed by the inadequacy of the data given and the relatively few controlled experiments conducted on which we depend for data. While it is evident that maturation and native intelligence play a most important part in reflective thinking, it is equally true that properly directed training may also influence young people toward the attitudes of the scientist and his approach to problems. But we have little evidence as to which of the above factors are of the most importance. In addition we see little evidence that the method of science is being used by education in solving our problem. Few cases, and fewer controlled experiments give us the slight knowledge we have at the present moment.

With this end in view I suggested to one of my students that he repeat an experiment already reported upon and insofar as possible, duplicate the study in a new environment. The digest of the Master's thesis that follows, although repre-

senting too few paired individuals to mean much statistically, is an indication of what must be done on a larger scale if we are to obtain trustworthy evidence.

Educational literature has for many years included the development of the scientific attitude as one of the important aims of education. Teachers of the natural sciences have largely assumed or have been given this responsibility. There is evidence of an apparent hiatus between the objectives of science teaching and the methods or techniques of teaching and testing for these results. This condition is partly due to a lack of general agreement and understanding as to what habits of thinking constitute the scientific attitude of mind. The definitions of the following authorities in the field of science education appear to confirm this point of view: Curtis [1], Skewes [2], Ebel [3], Noll [4], Davis [5], Preston [6], Schuyler [7], Milliken [8], and Dewey [9].

There is also a confusion as to methods and materials to be used in teaching and testing for these results, as may be seen by reference to the articles by Smith [10], Hoff [11], Blackman [12], Downing [13], Noll [14], Progressive Education Association [15], and Power [16], as well as many others.

Another important factor in this lack of agreement on methods of the research worker in science education is pointed out by Rebecca Brown of Winthrop Junior High School, when she states in speaking of work done by certain investigators, "There has been no duplication of the experiment by the investigator himself and there are no repetitions by others." [17]

In light of the above conditions, it was suggested that the writers take a given study, that of A. G. Hoff [18], and attempt to duplicate as far as possible the conditions given in his study as it applied in a small secondary school in a rural community.

STATEMENT OF THE PROBLEM

The purpose of this study was to determine objectively (a) The extent to which the scientific attitude is developed at the ninth grade level in general science where

[1] Curtis, Francis D. "Some Values Derived from Extensive Readings of General Science." New York, N. Y.: *Teachers College, Columbia University, Contribution No. 163.* Teachers College, Columbia University Press, 1924, page 41.

[2] Skewes, Geo. J. "What is the Scientific Attitude." *School Science and Mathematics* 33: 965–967; 1933.

[3] Ebel, Robert L. "Mental Attitudes." *Science Education* 22: 1–5; January, 1935.

Ebel, Robert L. "What Is The Scientific Attitude?" *Science Education* 22: 75–81; February, 1938.

[4] Noll, Victor H. "Measuring the Scientific Attitude." *The Journal of Abnormal Psychology* 30: 145–154; July, September, 1935.

[5] Davis, Ira C. "The Measuring of Scientific Attitudes." *Science Education* 19: 117–122.

[6] Preston, E. C. *High School Teacher and His Work.* McGraw and Hill, New York and London, 1936, p. 53–54.

[7] Schuyler, Jack. "Science and Society." *Journal of Adult Education* 9: 69–73; January, 1937.

[8] Milliken, Robert S. "Science and The Scientific Attitude." *Science* 86: 65–68; July 23, 1938, p. 66.

[9] Dewey, John. "The Supreme Intellectual Obligation." *Science Education* 18: 1–4; February, 1934, p. 3.

[10] Smith, Rufus Albert. "An Attempt to Measure Scientific Attitudes." *Master Thesis, George Peabody College for Teachers,* August, 1929.

[11] Hoff, A. G. "A Test for Scientific Attitude." *Master Thesis, University of Iowa,* 1930.

[12] Blackman, Abraham. "An Objective Test for the Scientific Attitude." *M. S. Thesis, College of the City of New York,* 1933.

[13] Downing, E. R. "Does Science Teach Scientific Thinking?" *Science Education* 17: 87–89; April, 1933.

[14] Noll, Victor H. "Teaching Science for Influencing Behavior." *Science Education* 20: 17–20; February, 1936.

[15] Progressive Education Association. *Science in General Education.* D. Appleton-Century Co., New York, 1938.

[16] Power, Carleton E. "Possible Techniques for the Development of Some Scientific Attitudes." *School Science and Mathematics* 39; March, 1939.

[17] Brown, Rebecca. "A Criticism of the Methods of Research Workers in Science Education." *Teaching Biologist,* Vol. VIII, No. 5, pp. 65–71; February, 1939.

[18] Hoff, A. G. "A Test for Scientific Attitude." *M.A. Thesis, University of Iowa,* 1930.

little or no emphasis is placed upon it; (b) the extent to which the scientific attitude is developed in the ninth and tenth grade students who have had no formal instruction in general science or biology; (c) the extent to which the scientific attitude can be developed when emphasis is placed upon this aspect of science teaching; and (d) the extent to which transfer of training takes place under the latter conditions.

GROUPS STUDIED

This study was made in the high school of Beaumont, California. All data were collected from the freshman, sophomore and junior classes of the school year 1938–39. The nature of the problem made it necessary to select three distinct groups of students.

Group I was taken from the sophomore and junior classes who had completed a year's course in general science during the school year of 1937–38. This group was taught by the writer using ordinary classroom procedure, demonstrations, field trips, motion pictures, class discussions and lectures. Little or no emphasis was placed upon the scientific attitude, although superstitions were discussed at some length. The text used did not emphasize the scientific attitude as a principal objective.

Group II was taken from the pupils of the freshman and sophomore classes who were studying general science during the school year 1938–39. This group was also taught by the writer and the same teaching procedure used as with Group I with the exception that the scientific attitude was emphasized throughout the course. The text used analyzed the scientific attitude and each habit of thinking was listed and clarified. In each unit some of these habits of thinking were recalled and applied in the solution of problems. The writer was careful to make additional references to these habits of thinking when possible and to generalize on their values in solving not only problems relating to science, but in solving social problems as well.

The following areas of reflective thinking were emphasized: habit of curiosity; a demand for accuracy; a knowledge of cause and effect relations; the need for adequate evidence to support conclusions; intellectual honesty; impartiality; suspended judgment; and respect for another's point of view.

Members of Groups I and II were eligible for the test used in the Hoff study if they had had no other science courses while in high school and if they had had no formal science instruction other than that given by the writer.

Group III was taken from the freshman, sophomore and junior classes who had had no formal instruction in the natural sciences. This was the control group for groups I and II.

COLLECTION OF DATA

As has been indicated, the data for the groups I, II, and III were collected from the freshman, sophomore and junior classes. There were about one hundred students of the three classes who were eligible to be placed in one of the three groups.

The following data were needed for each pupil: (1) student's name; (2) chronological age; (3) intelligence test score; (4) silent reading test score; (5) mental age; (6) average school grades; and (7) the scientific attitude test score.

The intelligence test score was obtained from the office records. In order to get the mental ages it was necessary to use the chronological ages with the intelligence quotients. The average school grades were taken from the office records. The grades were recorded alphabetically as A, B, C, D, and F. It was necessary for the writer to place numerical values on the grades for computation. The following values were

used in transposing: A–4; B–3; C–2; D–1; F–0. The reading test score was obtained from Form B, of the "Iowa Silent Reading Test." The scientific attitude test score was obtained from the Hoff "Scientific Attitude Test."

PAIRINGS

For the purpose of this study, it was desirable to match students from each of the three groups according to native and mental abilities. Due to environmental factors, such as public opinion, the varied impressions of childhood, fixed aversions and phobias implanted by ignorant associates and mental lethargy of parents, all of which directly affect the attitudes of students, it was concluded that the most equal basis upon which to group the students was that of mental age and sex.

The students thus paired did not vary in any case by more than one mental year, one pairing by one mental month, and the average was 8.9 mental months. The writer also kept the economic and social status of the pairing as nearly constant as possible. It was possible to get a matching of twenty-one students on the above basis. Table I shows the grouping of the individual students on the above basis.

TABLE I

GROUPS OF STUDENTS ARRANGED ACCORDING TO MENTAL AGES AND SEX

Sex	Group I No.	M.A.	Group II No.	M.A.	Group III No.	M.A.
Boys	1	20.5	22	19.7	43	20.4
B	2	19.8	23	18.11	44	19.8
B	3	19.2	24	18.5	45	18.6
Girls	4	18.5	25	18.5	46	18.11
B	5	18.4	26	17.6	47	17.8
B	6	17.2	27	16.3	48	17.1
B	7	17	28	16.5	49	17.2
B	8	17	29	17.5	50	17.11
G	9	16.10	30	17.1	51	16.9
B	10	16.4	31	16.2	52	15.8
B	11	15.11	32	15.2	53	14.11
G	12	15.11	33	16.5	54	15.7
B	13	15.10	34	15.1	55	15.10
B	14	15.8	35	15.6	56	15
B	15	15.5	36	14.8	57	14.8
G	16	15.3	37	15.10	58	15.6
B	17	14.5	38	14.6	59	14.6
B	18	14.11	39	14.4	60	14.6
B	19	14.1	40	13.6	61	14
B	20	13.7	41	13.11	62	13.10
B	21	12.5	42	13.0	63	12.6

NOTE: In the following tables, when reference is made to the ages of pupils, the decimal points between the years and months, *e.g.*, 16.4, means 16 years, 4 months.

ADMINISTERING THE TEST

After seven months of special instruction on the scientific attitude with Group II, the writer gave the three groups Hoff's "Test for the Scientific Attitude." [19]

While Group II had never been drilled on any of the questions in the test, they had been instructed on similar problems involving the same habits of thinking. They were also informed previously that such an examination would be given and that they should apply the principles studied in answering the test questions.

RESULTS OF THE EXPERIMENT

The scores from the attitude test were tabulated according to groups (see Table II). The average scores for the groups

TABLE II

MENTAL AGES WITH THE SCIENTIFIC ATTITUDE SCORES

Group I M.A.	S.A.S.	Group II M.A.	S.A.S.	Group III M.A.	S.A.S.
20.5	.790	19.7	.777	20.4	.766
19.8	.816	18.11	.673	18.8	.660
19.2	.780	18.5	.689	18.6	.720
18.5	.778	18.5	.760	18.11	.723
18.4	.783	17.6	.786	17.8	.766
17.2	.479	16.3	.533	17.1	.796
17.0	.635	16.5	.586	17.2	.720
17.0	.710	17.5	.786	17.11	.756
16.10	.710	17.1	.614	16.9	.630
16.4	.653	16.2	.623	15.8	.537
15.11	.746	15.2	.745	14.11	.681
15.11	.556	16.5	.803	15.7	.626
15.10	.708	15.1	.743	15.10	.709
15.8	.800	15.6	.660	15.0	.666
15.5	.866	14.8	.775	14.8	.713
15.3	.663	15.10	.576	15.6	.640
14.11	.643	14.4	.666	14.6	.730
14.5	.643	14.6	.765	14.6	.770
14.1	.520	13.6	.600	14.0	.684
13.7	.613	13.11	.603	13.10	.600
12.5	.716	13.0	.745	12.6	.536

[19] Hoff, A. G. *Op. cit.*

TABLE III

RELATIONSHIP OF I.Q.'S AND ATTITUDE SCORES

I.Q.	Attitude Score	I.Q.	Attitude Score	I.Q.	Attitude Score
136	.766	107.5	.780	99.0	.745
131.7	.777	107.2	.766	98.3	.640
133.7	.673	107.2	.709	97.8	
131	.723	106	.743	95.8	.708
130	.760	105.9	.710	95.6	.666
127.3	.790	105.2	.537	95.0	.643
126.9	.614	105.0	.803	95.0	.520
126.3	.816	105.0	.720	94.7	.800
122.7	.786	105.0	.576	94.7	.643
122	.689	104.5	.556	94.3	.770
120	.783	104.4	.653	93.1	.603
119	.650	104.1	.479	92.2	.663
119	.689	104	.713	91.9	.600
118.3	.533	102.8	.626	90.1	.666
115.5	.778	102.2	.745	90.0	.681
113	.796	101.2	.775	83.8	.520
110.8	.630	101.2	.765	83.1	.600
110.6	.710	101.2	.730	82.0	.745
109	.786	100	.786	81.5	.536
108.6	.623	99.4	.866	78.0	.613
108.1	.635	99.4	.586	74.4	.716

were as follows: Group I, .695; Group II, .695; Group III, .685. The median scores were as follows: Group I, .710; Group II, .689; Group III, .709. The range in scores was .387 for Group I; .270 for Group II; and .260 for Group III. These attitude test scores clearly indicate no marked difference of any group in the ability to think more scientifically than another.

The students were then tabulated according to I.Q.'s and scientific attitude scores. (See Table III.)

The I.Q.'s and attitude scores were then correlated according to the Pearson Product moment Coefficient of Correlation. This was .3400, which was not enough to be significant, as was found by Hoff.[20]

The average grades of the students were then computed and correlated with the scientific attitude scores. (See Table IV.)

The correlation between the average grades and the attitude scores was .4152; the correlations in the Hoff study ranged from .2509 to .4194, none of which are great enough to be significant.[21]

The correlation between the scores made in reading comprehension and the scores made on the attitude test was .3105. The correlation in the Hoff study was found to be $.1908 \pm .300$. (See Table V.) The correlation between scores made in the speed of reading and the scores made in the attitude test was .0312. The correlation in the Hoff study was found to be $.1717 \pm .0859$.

This would lead us to believe that the test tests something besides intelligence, reading ability or scholastic attainment.

[20] Hoff, A. G. *Op. cit.*, p. 31.

[21] *Op. cit.*, pp. 36–38.

TABLE IV

RELATION OF SCIENTIFIC ATTITUDE SCORES WITH AVERAGE GRADES

S.A.S.	Av. Gr.	S.A.S.	Av. Gr.	S.A.S.	Av. Gr.	S.A.S.	Av. Gr.
.866	2.62	.765	2.43	.681	1.57	.613	1.05
.816	3.70	.760	2.40	.673	3.34	.603	1.75
.803	2.10	.756	2.08	.666	1.79	.600	1.46
.809	1.70	.745	2.75	.666	2.31	.600	1.53
.796	2.30	.745	2.15	.663	2.02	.586	2.67
.790	2.45	.745	3.63	.660	1.78	.576	2.30
.786	2.53	.743	1.80	.653	2.63	.556	2.06
.786	3.44	.730	2.07	.650	2.12	.537	2.75
.783	3.21	.723	2.58	.643	2.27	.536	1.08
.780	2.40	.720	3.27	.643	1.58	.533	2.68
.778	3.30	.716	1.60	.640	2.55	.520	1.72
.777	3.47	.713	2.63	.635	3.70	.520	1.34
.775	1.90	.710	2.26	.630	2.47	.480	1.53
.770	2.00	.709	2.09	.626	2.80	.480	1.45
.766	3.44	.708	1.88	.623	3.25	.479	1.51
.766	1.88	.689	3.10	.614	3.05		

TABLE V

RELATIONSHIP OF THE SCIENTIFIC ATTITUDE SCORES MADE IN COMPREHENSION AND SPEED OF READING

No.	S.A.S.	Read. Comp.	Speed of Read.	No.	S.A.S.	Read. Comp.	Speed of Read.	No.	S.A.S.	Read. Comp.	Speed of Read.
1	.790	153	52	22	.777	165	35	43	.766	180	39
2	.816	158.5	52	23	.673	141	30	44	.650	142.5	35
3	.780	143.5	27	24	.689	174	43	45	.720	82	49
4	.778			25	.760	157	36	46	.723	178.5	36
5	.783	185.5	62	26	.786	75	—3	47	.766	143.5	44
6	.479	101	26	27	.533	114	13	48	.796	75	10
7	.635	107.5	13	28	.586	134	38	49	.720	106	36
8	.710	122.5	44	29	.786	135	28	50	.756	125.5	27
9	.710	111	13	30	.614	120.5	17	51	.630	103.5	22
10	.653	110	30	31	.623	123.5	7	52	.537	71	28
11	.746	143	45	32	.745	75.5	18	53	.681		
12	.556	94	36	33	.803	123	29	54	.626	81.5	10
13	.708	72	—7	34	.743	119	35	55	.709	105	38
14	.800	72	17	35	.660	106.5	13	56	.666	55	—8
15	.866	128	40	36	.775	72.5	25	57	.713	69.5	8
16	.663	53	10	37	.576	89	3	58	.640	73	28
17	.643	76.5	31	38	.666	88	11	59	.730	101	19
18	.643	106.5	7	39	.765	60	17	60	.770	79	29
19	.520	81	15	40	.600	94.5	39	61	.684	87	32
20	.613	55	16	41	.603			62	.600	40	2
21	.716	20	16	42	.745	67	38	63	.716	89	18

The writers then arranged the groups according to chronological ages and found that Group II had an average age of 14.9 years while the other two groups had an average age of 15.2 years. Group II ranged from 13.6 years to 16.9 years, while Groups I and III were 14.1 years to 17.11 years. A fraction more than 71 per cent in Groups I and III were over 15.3 years (see Table VI). The average attitude score for the students below 15.3 years was .674 and the average grades for the students above 15.3 years was .703 or a fraction more than four per cent higher.

TABLE VI

SHOWING CHRONOLOGICAL AGES WITH THE SCIENTIFIC ATTITUDE SCORES

C.A.	S.A.S.	C.A.	S.A.S.	C.A.	S.A.S.	C.A.	S.A.S.
13.6	614	14.11	766	15.8	816	16.6	766
14.1	750	15	609	15.8	803	16.7	746
14.2	765	15	603	15.8	745	16.7	653
14.2	533	15	666	15.8	643	16.7	666
14.2	673	15.1	689	15.9	536	16.8	716
14.3	743	15.1	576	15.9	640	16.9	613
14.5	775	15.1	630	15.9	610	16.9	586
14.5	786	15.2	650	15.9	790	16.10	479
14.5	730	15.3	745	15.10	660	16.10	520
14.6	709	15.3	556	15.11	710	17.1	720
14.6	723	15.3	626	16	778	17.1	684
14.10	643	15.4	770	16.1	783	17.5	800
14.11	777	15.6	866	16.1	786	17.9	708
14.11	623	15.6	796	16.4	600	17.10	780
14.11	537	15.6	720	16.5	710	17.11	756
14.11	713	15.7	663	16.6	681		

CONCLUSIONS

On the basis of the above study it is reasonable to conclude that the added emphasis given in the teaching of the scientific attitude and the using of a text that is organized for the purpose of directly imparting skill in this type of thinking does not modify the scientific attitude scores. The writers doubt the ability of changing the skill in scientific thinking through classroom teaching procedures carried on for the time given in this experiment. This may be due in part to the inability to maintain sufficient teaching controls between Group I and Group II. That this is a very difficult task is pointed out by Hunter when he states, "The results we would obtain are imperfect and inexact. But we may, at least, attempt to carry out our experiment in the spirit of the scientific investigator." [22]

Another factor which undoubtedly caused the group to be relatively even in attitude scores is that of maturation. Groups I and III were actually older in years and months because they were taken largely from the sophomore and junior classes. While Group II was nearly equal according to mental ages, maturity, especially at these ages, does affect the ability of the child to think scientifically. This appears to agree with the study made by Strauss.[23]

It is probable that subjects, other than general science, were a contributing factor in the developing of the scientific attitude. This is pointed out by Faris, who says, "The teaching of history and of literature are primarily undertakings for the purpose of producing attitudes toward this nation and other nations, toward social and moral objects which the community approves." [24]

While the correlations between the scores made in this study are practically the same as those in the Hoff study, it is the opinion of the writer that it would be advantageous to rewrite the test for clarity and comprehension.

Hoff concurs with this when he states, "Further studies on the subject of scientific attitude may produce a more valid and reliable test by: 'A restatement of the situations so that a more satisfactory set of responses can be employed.' " [25]

The work that has been described in this study should by no means be taken as a final conclusion, but merely as a tentative and experimental approach to what seems to the writer an important problem.

[22] Hunter, George W. "An Experiment in the Use of Three Different Methods of Teaching in the Class Room." Reprint from *School Science and Mathematics* 32: 21; 1922.

[23] Strauss, Sam. "Some Results for the Test of Scientific Thinking." *Science Education* 16: 89–93; December, 1931, p. 92.

[24] Faris, Ellsworth. "Attitudes and Behavior." *American Journal of Sociology* 34: 271–281; September, 1928, p. 271.

[25] Hoff, A. G. *Op. cit.*, p. 40.

THE CONSTRUCTION OF THE PRINCIPLES OF HIGH SCHOOL PHYSICS

H. M. Stockder

Instructor in Physics, Milwaukee Vocational School, Milwaukee, Wisconsin

The purpose of this article is first, to indicate certain discrepancies and inconsistencies which appear to be included in the statements of the principles in high school physics textbooks; second, to suggest implications which these may have upon the learning situation; and third, to point out the basis for a procedure of both diagnostic and remedial nature, whose object is the removal of the defects alluded to.

A principle is a definite statement of a fundamental truth. It deals with something directly observable as an action, appearance, change, or occurrence in the field. A modern physics textbook includes statements which range in number from one hundred seventy-five to two hundred fifty, which are variously designated or indexed in the book as principles, laws, and theories. Such a group is apparently the generalizations of the sciences; it includes, or comprises, the major generalizations.

The position of these principles in the learning situation is explicitly stated in the aims of teaching science, namely, the achievement of the functional understanding of the major generalizations. Directed experiment, demonstration, subject matter content, and problem solution are selected and arranged for the drawing of the generalizations as well as their applications in prepared situations. Functional understanding is comparable to a reversible process; it implies both deduction and induction; it includes both the specifying from a principle and the generalizing from assembled data or phenomena. The attainment of the aims of teaching science demands that all parts of the learning situation are carefully prepared for all aspects of the situation in which they are used.

In what respects do the statements of the principles of physics exhibit discrepancies and inconsistencies? This question does not attempt to take issue with the scientific accuracy of the statements themselves; it is recognized that the scope of the field, the difficulty level of the course, and the supporting phenomena and formulas, all condition the extent of scientific accuracy possible. However, the aspects of construction of the statements themselves, throw considerable light upon a very fundamental part of the question. The constructional aspects of the principles, which are exhibited by the arrangements of the component parts of the statements as well as by significance which the parts themselves have in their relation to the statement as a whole, appear to indicate a lack of preparation which results in the inclusion of defects within the group.

Consider the statement of the principle of Archimedes, as drawn from a widely used physics textbook:

> "A body either partly or wholly submerged in a fluid is buoyed up by a force equal to the weight of the displaced fluid."

This principle deals with a buoyant *force,* which is directly observable and which changes quantitatively; it states a relationship, *is equal to,* which the variable has to a factor in the field, *the weight of the displaced fluid;* it further includes a combination of limiting conditions within which the statement holds true.

The arrangement of these component parts within the statement places the subject, or variable, after the combination of limiting conditions; grammatically, it is placed well within the predicate of the sentence. The constructional emphasis is

on the situation rather than on the variable. The statements of the principles of physics appearing in textbooks are almost evenly divided with respect to the constructional emphasis placed upon the variable. In about half of these, either the limiting conditions or the expressions of relationship used (and sometimes both), precede the variable. In the remainder, the variable is the grammatical subject of the statement and precedes both the other parts.

The significance which the parts of the statement have in their relation to the statement as a whole shows a wide range of aspects. Outstanding among these is the significance of the designations of matter used in the principles. Archimedes' principle, as stated, uses the designation *body*. Is the full meaning of this statement dependent upon the use of this term? Other principles in the field of mechanics designate matter by *mass, matter, material, object, particle, solid, substance,* and *weight*. Are there finely drawn distinctions between such designations which preclude the use of any particular one in a given situation?

As a general rule, statements of principles apparently tend to use designations of matter which are in some way related to the field from which the principle is drawn. The terms appearing in principles in mechanics have been cited; in electricity, such terms as *conductor, resistance,* and *circuit* predominate; light furnishes *source, reflector,* and *medium*. At least thirty-eight terms are used to designate matter in the principles. They range from such highly significant terms as *radiator* and *electrolyte* to the vague *particle* or *something*. The particular significance of these expressions upon the principle as a whole appears to lie in the limitations with which they, somewhat insidiously, condition an otherwise simple and direct statement.

Of almost equal rank with the designations of matter is the wide variety of expressions used to state the relationships in accord with which actions, appearances, changes, or occurrences take place. A simple and direct relationship is expressed by *is equal to* in the principle which has been quoted. It is supported by formulas in the accompanying subject matter; its subject is the variable with which the principle deals; its predicate consists of concrete terms of related significance. However, the use of expressions such as *is the same as* and *is equivalent to,* which appear in other principles, raises the question of fine drawn distinctions in the meanings of the expressions.

The expressions of relationship which are used to indicate proportionality exhibit greater variety. No less than seven such expressions appear in the statements; they are: *varies as, varies directly as, is proportional to, is directly proportional to, increases with, is increased,* and *has same relation to*. Each principle, in which one of those expressions of proportionality appear, is supported by formula based upon simple proportion. In contrast, a number of principles contain expressions of conditional relationship; some of these expressions are: *is considered to be, may be, should depend upon,* and *tends*. None of the last named group are supported by any formulas in the scope of the textbook.

The significance of such variety among expressions of relationship upon the statement as a whole appears to be a tendency to associate a more or less relative degree of scientific accuracy with the statement of a fundamental truth. The various levels of a rather distinct gradient of reliability is apparent in the relationships *tends, increases with, is proportional to,* and *is directly proportional to*. It is possible that here, as in the designations of matter, the expressions used are selected with the objective of making unnecessary a more complete delimitation of the scope of the statement. On the other hand, the degree of emphasis which the statements of proportionality are given in relation one to another, is difficult to understand. There are no degrees of a proportionality which

exists between concrete terms; either they are proportional or they are not. Does such emphasis also reflect upon the scope or the range of conditions through which the statement holds true?

What are the implications which these characteristics suggest? These are discussed with reference to the materials of instruction and to the learning situation in which they are involved.

The general lack of uniformity which the statements as a whole exhibit suggests the question: What are the sources of the principles of physics which appear in our textbooks? Their ultimate sources lie in the past twenty centuries and are written in nearly as many languages. Their abstraction and restatement makes considerable demands upon the authors of the textbooks, and results in a variety of statements which is possibly dependent upon scope, viewpoint, and application. Archimedes' Principle is stated in four different ways in as many textbooks: Hooke's law, Pascal's law, and the law of conservation of energy are each found in three different forms in books of the high school level. Ultimately, what are the criteria for abstracting or restating principles from some direct source? Both the aims of teaching science and the presentation of the subject matter have undergone thorough changes in the past years. Is it possible that the construction of the statements of the principles has not kept pace with changes in the other materials and is still associated with the older order?

This is bearing directly upon the learning situation. The achievement of the functional understanding of the major generalizations of physics is perhaps best attained when all parts incident to the learning situation are commonly integrated for the purpose they serve. By implication, the lack of uniformity which the statements of the principles exhibit does not contribute toward this end. Some of the aspects of construction of the statements apparently constitute obstacles of no mean importance to student and instructor.

The extreme form of specialization which results in designating matter with respect to the peculiar properties it may have in the field of the principle is a source of confusion. Physics deals largely with quantitative terms. The ability to visualize these is an important outcome of teaching science. The general conception of matter which a student achieves must be compatible with some thirty-eight different designations, each of which emphasizes one property more or less to the exclusion of other properties. The "ohm saw" of shop legend is in the physics room.

What is a basis of procedure, both diagnostic and remedial in nature, which will eliminate the discrepancies and inconsistencies in the construction of the statements? The plea is made for uniformity in construction and arrangement of those statements which constitute an accepted group of the principles of physics. This uniformity is to be based upon standards which maintain scientific accuracy compatible with the difficulty level of the course, and, at the same time, contribute to the fullest extent toward the complete achievement of the functional understanding of the principles.

The attempt has been made to present certain characteristics in the construction of the statements which appear to indicate a general lack of uniformity; that parts of the statements are emphasized and a variety of terms used which may be obstacles to the full achievement of the aims. While the immediate remedy of the situation lies in the removal of the offending parts, the problem as a whole is first, to discover that which is undesirable as well as that which is desirable; and second, to construct statements from accepted sources which satisfy both the scientific and the educational situations involved.

Editorials and Educational News

A SCIENCE PROGRAM FOR ALL STUDENTS

A casual survey of the development of our science program will reveal that generalized courses have gradually displaced the more specialized courses. The younger teachers may not remember the separate courses in botany, zoology and human physiology, but many active science teachers can remember the years when general science and general biology made great progress in winning the support of many schools and pupils. During the last few years we have been witnessing the coming of consumer science, integrated science, descriptive science, core-curriculum science, and similar courses. These herald the coming of several generalized courses which may, within a decade or two, settle down to one or more generalized courses which will be rather widely accepted by schools and pupils. One of these new generalized courses may be an attempt to integrate the physical sciences much as the biological sciences are now integrated. Another may be a core-curriculum study in which the science is integrated with one or more other subjects and all taught by the one teacher.

When botany, zoology, human physiology, and physical geography were shrinking in the face of the growth of general science and general biology, there were many and often loud expressions of regret and fear. Many teachers and subject matter specialists predicted dire results and called on each other to give support to the subjects through which they had achieved their preparation. Now many physics and chemistry teachers are calling on each other for support because their realm is being invaded by attempts at fusion. Similarly, science teachers are now beginning to fear the results of the core-curriculum type of science. If we may predict the effect on physics and chemistry from the effects produced by the introduction of biology, then we may say that these subjects, as now organized, are on the way out. The success of core-curriculum science would mean that both biological and physical sciences, as now organized, would be dropped.

Along with these developments toward integration, it is pertinent to call attention to the organization and growth of associations of science teachers affiliated with science organizations composed of teachers working largely at college levels. Here we may mention such groups as the Division of Chemical Education, The American Science Teachers Association, The American Association of Physics Teachers, The American Association of Biology Teachers. These groups are, more or less, obviously organized to promote the development of the sciences and hinder the invasion of their realm by generalized courses. Many of the members of these groups label the generalized courses as "neither integrated nor scientific." They often call these attempts, "scrambled science" or "glorified general science."

Here indeed are trends which are at the stage where we as science teachers may influence them. We may encourage the movement toward generalized physical and core-curriculum science or we may stand firm in the defense of the subjects as we know them. Should we be conservatives or rebels? Should we be neutrals or participants? Should we be isolationists, interested observers, or supporters? What kind of a science program do we want?

Personally, I cannot enlist wholeheartedly on either the progressive or the conservative side. I desire to promote generalized courses which are integrated and scientific, as well as to promote the introduction or re-introduction and growth of the specialized sciences. This means that

for secondary levels I believe in well-balanced, integrated, and substantial general science courses, to give the boys and girls the general understandings, attitudes, and scientific facts which are necessary for interesting and intelligent living. These general science courses should include the biological, physical, earth, and astronomical sciences. Following the general science, there should be semi-specialization and a deeper penetration into the understandings, attitudes and mastery of facts, in two broad science areas; the biological sciences and the physical sciences. The latter should include some earth science and astronomy. Following these two broad courses there should be one or more specialized courses. The offerings at this level would be determined largely by the interests of the students, the vocational and recreational opportunities in the community, and the competency of the teachers. These courses for the twelfth year and post graduate levels may include one or more such courses as: Floriculture, Gardening, Botany, Biology, Bacteriology, Physiology, Physics, Chemistry, Chemistry for Nurses, Electronics, Geology, Astronomy, Photography, Aerodynamics, Entomology, and others. Of course, the physics and chemistry at this level would be different from the courses as we know them, because much basic physics and chemistry would have been mastered in the earlier courses. After the semi-specialization in biology and general physical science, students may elect for one or more terms in courses which give them more thorough preparation in one or more circumscribed areas.

According to this plan, all schools would offer a twelve year science program, composed of six years elementary science, three years general science, one year biological science, one year general physical science, and one or more terms of some rather specialized sciences. All along this program there should be intelligent cooperation with the teachers of other subjects so that all the offerings of the school may become a meaningful whole rather than a number of rather isolated parcels. Thus, whenever a student happened to drop out of school, he would go with a maximum of that general preparation which would help him to live understandingly and eagerly in a world of science.

Where do you stand in relation to the developments which face us?

PHILIP G. JOHNSON,
Cornell University

AMERICAN EDUCATION WEEK

"Education for the Common Defense" is the general theme for the twentieth annual observance of American Education Week, November 10–16, 1940. No theme could be more appropriate to the present period. This occasion offers an unparalleled opportunity to interpret the contribution of the schools to the common defense of the American way of life.

The daily topics for the observance are:

- Sunday, November 10—Enriching Spiritual Life
- Monday, November 11—Strengthening Civic Loyalties
- Tuesday, November 12—Financing Public Education
- Wednesday, November 13—Developing Human Resources
- Thursday, November 14—Safeguarding Natural Resources
- Friday, November 15—Perpetuating Individual Liberties
- Saturday, November 16—Building Economic Security

The National Education Association has prepared materials to assist schools and communities in the observance including a 32-page handbook of American Education Week technics, a 332-page booklet entitled, "Education for the Common Defense" every second page of which consists of cartoon illustrations, a poster, a leaflet for distribution to homes, a sticker, a series of eight-page folders giving specific suggestions on the various topics for different

school levels, and combination packets of materials for the different school levels.

Address the National Education Association, 1201 Sixteenth Street, N. W., Washington, D. C., for complete information regarding American Education Week materials available at low cost prices.

A subsequent release from the Association supplements the announcement with a four-page statement describing methods for positive action in making Education Week a real contribution to the defense of American Democracy. Specific and helpful suggestions are made (a) for organizing and conducting a committee in the local area, (b) for in-school education for defense, (c) newspaper cooperation, (d) for radio cooperation, and (e) for cooperation with local organizations.

The plea for making American Education Week a particularly successful one this year will not fall on deaf ears among science teachers. The daily topics for Wednesday and Thursday should provide many leads for the wide-awake teacher of science.

DEMOCRACY AND EDUCATION IN THE CURRENT CRISIS

A challenging and valuable manifesto under this title has been issued recently in a thirteen-page printed pamphlet by 122 members of the Faculty of Teachers College, Columbia University. Following a prefatory statement on the gravity of the present situation, there follows a listing of the assets of our nation in terms of ideals which we can use in the defense of democracy. The meaning of democracy is elaborated next under nine brief sections. Lastly, there is stated a creed of democracy in terms of desirable beliefs and dispositions to act.

Single copies will be sent free. Copies in quantity may be had at the cost of $1.80 per hundred from the Bureau of Publications, Teachers College, Columbia University, New York City.

FILM INFORMATION SERVICE

Notice has been received regarding the organization of a Film Information Service which will publish a monthly bulletin listing new and selected older films of a commercial and industrial nature, and containing bibliographies of books and articles relating to visual education. No attempt will be made to provide a directory of educational films in view of the fact that such directories are available from various sources.

The organization states that it will make an effort to fill in the gap left by the discontinuance of the U. S. Government Film Service last June, and will become a central source for information on educational films. Subscriptions to the monthly bulletin are one dollar per year with reduced rates for additional subscriptions at the same address. The Service is located at 535 Hearst-Tower Building, Baltimore, Maryland. Apparently, the organization is a private venture.

EDUCATION AND ECONOMIC WELL-BEING

The American Policies Commission in its publication, *Education and Economic Well-Being in American Democracy*, presents a strong plea on the thesis "that the right kind and amount of education for every youth tends to increase the production and to improve the use and distribution of economic goods and services, thereby increasing the national income."

The publication contains much of value which should be contemplated and acted upon by the teacher of science. Education for better standards in the purchase of foods, clothing, shelter, health services and recreation is advocated. Further, the Commission reminds us that all youth whether entering upon college, the skilled trades or technical pursuits, should obtain in the secondary school a broad knowledge of economic problems, industrial relations

and the contributions of science to modern civilization. These are but two of many references to the contributions which functional teaching of science may make to economic well-being.

JUNIOR COLLEGES

Need for terminal education in junior colleges is being discussed this fall in 20 conferences in a nationwide series, under the sponsorship of the American Association of Junior Colleges. A few quotations from a release of the Association will be of interest to our readers and will suggest to science teachers certain items to which we must direct attention in making our science courses contribute their part in the general education of youth.

Although 66 per cent of junior college students prepare to go on into four-year colleges or universities, only 25 per cent actually do go on, says Dr. Walter C. Eells of Washington, D. C., director of the Commission on Junior College Terminal Education, in leading the discussions. This situation, he insists, is untenable, since "students should not be educated for something they will not do if they can be better educated for the things they will do. The things they will do are to seek employment, enter into citizenship and establish homes."

Figures presented by Dr. Eells show how the junior colleges in the several accrediting areas compare with the national average in what might be called the misdirection of student effort. The percentage of junior college students who prepare to go on into senior colleges or universities is compared with the percentage who actually continue:

	Prepare	Continue
United States	66	25
New England	35	27
Middle States	68	32
North Central	77	27
Southern	69	25
Northwest	78	26

"The time has passed," says Dr. Eells, "when everyone who goes to college can be educated for a profession. The professions absorb only six per cent of the population. Preparation for these professions is the primary function of the universities. But approximately one-half of the gainful workers in the country, proprietors, managers, clerical and skilled labor, are in occupations which are distinctly on the semiprofessional level.

"Here is a wide open field for the junior colleges. More than 300 junior colleges are already giving semiprofessional and general education to about one-third of their 120,000 students. But among all the 600 junior colleges in the country, with 200,000 students, the proportion is far lower."

ADVENTURES IN BIOLOGY

A second edition of *Adventures in Biology* (1940), by the New York City Association of Biology Teachers, represents a marked advance over the 1934 edition. The committee which prepared the new monograph deserves our hearty congratulations for an outstanding contribution to the teaching of biology.

Two hundred sixty-five projects, with directions, are classified under eight groups, each group representing a major topic or unit of a course in biology. Four hundred forty-six books and pamphlets are found in the bibliography of publications to which specific references are made in the directions for the projects.

While it is true that many of the projects are concerned with the plant and environment of New York City, the monograph will enrich any course in biology. Suggestions for the use of the projects are contained in an excellently-written introduction. At the end of the monograph is a particularly helpful index to the projects. This index is in three sections (1) projects involving various types of activities, such as growing plants, making apparatus, and using a camera, (2) projects involving biological ideas, such as absorption, germination and hormone action, and (3) projects involving different kinds of organisms, such as protozoa, insects, and trees.

Information concerning the monograph is obtainable from Mrs. Estella R. Steiner, Grover Cleveland High School, 2127 Himrod Street, New York City.

ELEMENTARY SCIENCE COUNCIL

The Long Island Elementary Science Council was organized in March, 1939.

The purpose was stated: to act as a forum or clearing house for the problems of Long Island teachers interested in teaching science in the elementary school.

In order to determine what these problems were a questionnaire was presented at the first meeting on March 8, 1939, at the Plandome Road School in Manhasset, L. I. Results were tabulated. The following list of questions is arranged in the order of their importance to the one hundred teachers present at that meeting:

(1) What materials are available for the teaching science?
(2) How does one determine what materials to give children on their age level?
(3) How can we evaluate the outcomes of science teaching?
(4) How can science enrich the elementary school program?
(5) How can one get content for the teaching of elementary science?
(6) How would you get elementary science started in the classroom?

In addition, at the first meeting, members of the Executive Committee discussed (1) the status of science teaching in the elementary school, (2) science as related to contemporary life and to the school program, and (3) why teach science in the elementary school.

Successive meetings have attempted to answer the problems and questions of teachers as determined by the questionnaire. Mr. W. W. McSpadden presented materials used and results of work done by sixth-grade children in the field of electricity. This meeting ended the work of the Council for the school year of 1939.

The school year 1939–1940 opened with the Council presenting on October 6, 1939, a panel consisting of both elementary and secondary school people. This panel considered the value of teaching science in the elementary school before the science section of the Long Island Zone meeting of the New York State Teachers Association in Hempstead.

The Council presented at their next meeting experiments using inexpensive material that could be used in the field of air pressure from the primary level to the upper intermediate. The experiments were presented by Mr. Ernest Owen, consultant, Mr. Robert Wilson, science teacher, and Mrs. Scott, classroom teacher.

Two groups of children from the Manhasset and Garden City Schools demonstrated science learnings for the Council's third meeting.

On May 9, 1940, at the East Street School in Hicksville, the Council turned its attention to science books and a suggested outfit of science equipment. This terminated the year's program of the Long Island Science Council attended by enthusiastic classroom teachers throughout the year.

The business of the organization is conducted by the Executive Committee. Occasional guests are invited to these Executive meetings to give their aid and suggestions in planning the future meetings and policies of the Council. The Executive Committee originally consisted of four people and has increased to seven. The members at present are: Miss Helene Nichols, Science Consultant, Manhasset; Mr. O. J. LuPone, Science Teacher, Northport; Mr. Ernest Owen, Consultant, Garden City; Miss Eugenia J. Breeze, Classroom Teacher, Glenwood Landing; Mr. Robert Wilson, Science Teacher, Merrick; Mr. Leonard Davenport, Teacher of Social Studies, Hempstead; and Mrs. Mary Demerec, Classroom Teacher, Cold Spring Harbor.

The Long Island Elementary Science Council has had a very successful existence during the past year and one half, and is looking forward to furthering the cause of elementary science and to being of real service to the Long Island teachers in the future.

CONSUMERS' RESEARCH

Our December, 1939, issue contained a review of *Guinea Pigs and Bugbears* by G. L. Eskew.

Under date of April 24, 1940, we received from Mr. William Considine of Waugh, Torpey and Considine, Newark, N. J., a letter which we quote:

April 24, 1940.

Editor
Science Education
374 Broadway
Albany, New York

Dear Sir:

We represent Consumers' Research, Inc., which corporation was mentioned in the review of Guinea Pigs and Bugbears in your issue of December, 1939. May we point out to you that the review is libelous in its statements concerning our client. As examples of these libels are the following: ". . . the laboratory testing facilities on which Consumer's Research base their recommendations and condemnations are actually nil." ". . . Consumer's Research is in operation for the sole benefits of the owners who are paid handsome royalties for their meager researches."

We do not feel that the position taken by your reviewer in the closing two sentences of the review in any way ameliorates the libels stated earlier. Nor is the libel in any way excused by the fact that it may be a repetition of a statement by the author of the book reviewed.

For your information and putting you on notice to call the same to the attention of your subscribers, Consumers' Research, Inc., is a non-profit corporation and from any surplus remaining at the end of any fiscal year the employees, officers, or trustees in no way profit. Royalties from the various books and fees from the various lectures are the property of the corporation and not of the individual member, trustee or officer.

There might be some question as to whether our client's laboratory testing facilities are good or bad. That is a matter of opinion. However, there can be no question that these facilities are actually nil.

We feel that the various libelous statements contained in the above mentioned article should have been checked by you and the truth ascertained. We again demand that you call the correction of these libelous statements to the attention of your readers in an early issue of your magazine. We are sending a copy of this letter to Clarence M. Pruitt at College Station, Stillwater, Okla.

Very truly yours,
(Signed) WILLIAM CONSIDINE.

Following receipt of this letter we wrote Consumers' Research expressing our regret at learning that the review had offended them and assuring them that we should like to continue our cordial attitude toward them as well as to review their publications in the future. Under date of June 19, 1940, a letter from Consumers' Research contained the request that we publish paragraphs 1, 3, 4 and 5 of Mr. Considine's letter. This we are glad to do.

PYREX GLASS

The U. S. Circuit Court of Appeals in St. Louis recently ruled that the word "Pyrex," a trade-mark of Corning Glass Works, is not public property. This ruling confirms Corning's ownership and exclusive right to the use of the word "Pyrex" which it adopted in 1915.

Enriching Science Teaching

Editor's Note:

This section takes the place of Classroom Notes *which has been included as a section of the Journal for many issues. The new section will list from time to time helpful items under all or some of the following subordinate heads:*

Demonstrations and Experiments
Pupil Activities and Projects
Visual Aids
Science Pamphlets and Bulletins
(a) U. S. Government
(b) Non-Government
Courses of Study and Units of Study in Science and Related Fields
Pamphlets for the Science Teacher
Science Tests
Research Bulletins of Interest to Science Teachers

Our readers are invited to submit information on any recent materials which should be mentioned in future listings. A credit line will be included for each contributor of usable material. Especially do we desire to have you send us brief descriptions with drawings of any demonstrations, experiments, home-made exhibits and visual aids which you have found successful in your classroom teaching.

Pupil Activities and Projects

Adventures in Biology. New York City Association of Biology Teachers, Grover Cleveland High School, Brooklyn, New York. 1940. 110 p. (Directions for 265 pupil projects in biology.)

Experimenting with Soils in the Elementary Grades. State Teachers College, Mayville, North Dakota. 1940. 8 p.

Catalog of Excursions for Intermediate Grade Pupils. By Mary M. Marutz and Elga M. Shearer. Long Beach City Schools, Long Beach, California. 1940. 88 p. (Mimeographed.)

Science Experiments for Little Children. By Charlotte G. Garrison. Charles Scribner's Sons, New York, N. Y. 1939. 111 p. $1.50.

Visual Aids

Eastman Teaching Films, Inc., Rochester, N. Y. 16mm., silent films. (Purchase.)
Chemical Effects of Electricity
Cattle
Transportation on the Great Lakes
Baby Beavers

Western Pine Association, Yeon Building, Portland, Oregon. 16mm. or 35mm., sound films. (Transportation charge.)
Building a Home with Western Pines
Harvesting the Western Pines
Fabricating the Western Pines

U. S. Department of Interior. Bureau of Mines Experiment Station, 4800 Forbes Street, Pittsburgh, Pa. 16mm., silent films. (Transportation charge.)
The Making and Shaping of Steel
Reel 1. "Raw Materials"
Reel 2. "The Refining of Steel"
Reel 3. "Flat Rolled Products"
Reel 4. "Bars and Structural Shapes"
Reel 5. "Rails, Wheels and Axles"
Reel 6. "Wire and Wire Products"
Reel 7. "Pipe and Tube Manufacture"
Alloy Steels: A Story of Their Development
Mineral Resources and Scenic Wonders of Arizona
The Story of Gasoline
The Story of Lubricating Oil
Automobile Lubrication

Key Cards and Class-Room Charts. General Biological Supply House, Inc., 761 East 69th Place, Chicago, Ill.
CR3.9 Malaria Life Cycle
CR8.61 Trichina Anatomy and Life Cycle
CR27.10 Frog Embryo
CR29.20 Gametes
CR29.21 Cleavage Types
CR29.23 Gastrula Types
CR71.6 Pollination of Flowers

Science Pamphlets and Bulletins

A. U. S. GOVERNMENT

Ground and Polished Lenses for Sun Glasses. Department of Commerce, National Bureau of Standards. Commercial Standard CS 78–39. Superintendent of Documents, Washington, D. C. 1940. 7 p. 5 cents.

Safety Factors in Construction and Ventilation, Wowona Vehicular Tunnel, Yosemite National Park. Department of Interior, Bureau of Mines, Technical Paper 608. Superintendent of Documents, Washington, D. C. 1940. 34 p. 20 cents.

Saving Soil with Sod in the Ohio Valley Region. U. S. Department of Agriculture, Farmers' Bulletin No. 1836. Superintendent of Documents, Washington, D. C. 1939. 29 p. 5 cents.

The Canning Industry in Ohio. Occupational Study No. 4. By Mary J. Drucker. National Youth Administration, Columbus, Ohio. 1940. 77 p. (Mimeographed.)

The 4-H Club Insect Manual. U. S. Department of Agriculture, Miscellaneous Publication No. 318. Superintendent of Documents, Washington, D. C. 1940. 62 p. 15 cents.

The Liming of Soils. U. S. Department of Agriculture, Farmers' Bulletin No. 1845. Superintendent of Documents, Washington, D. C. 1940. 25 p. 5 cents.

The Lumber Industry of Washington and the Pacific Northwest. Industrial Study No. 1. By William Ray Melton. National Youth Administration, Tacoma, Washington. 1940. 159 p. (Mimeographed.)

The Machine Tool Industry in Ohio. Occupational Study No. 5. By Wilmur R. Hanawalt.

National Youth Administration, Columbus, Ohio. 1940. 119 p. (Mimeographed.)

The Peach Borer: How to Prevent or Lessen Its Ravages. U. S. Department of Agriculture, Farmers' Bulletin No. 1246. Superintendent of Documents, Washington, D. C. 1940. 13 p. 5 cents.

The Railroad Industry. By Stewart Lotys Benning. National Youth Administration, 413 Century Building, Indianapolis, Indiana. 1940. 119 p. (Mimeographed.)

B. NON-GOVERNMENT

A Key to the Snakes of the United States. By C. B. Perkins. Bulletin No. 16. Zoological Society, San Diego, California. 1940. 64 p. 85 cents.

Hardy Ferns and Their Culture. By Carol H. Woodward and others. New York Botanical Garden, Bronx Park, New York, N. Y. 1940. 40 p. 25 cents.

Leaflets on Occupations. Occupational Index, Inc., New York University, Washington Square East, New York, N. Y. 25 cents each.

New Worlds in Engineering. Chrysler Corporation, Detroit, Michigan. 1940. 96 p.

Nature Handbook for Sportsmen and Conservationists. By Horace L. Poole. The author, 1954 Ellis Street, Dubuque, Iowa. 1940. 56 p. 30 cents.

Railroads. Building America, Volume 5, Number 6. E. M. Hale and Company, 5193 Plankinton Arcade, Milwaukee, Wisconsin. March, 1940. 30 p. 30 cents.

The Opportunity for Youth in Building the World of Tomorrow. General Motors Corporation, 1775 Broadway, New York, N. Y. 1940. 24 p.

The Rockefeller Foundation: A Review for 1939. By Raymond B. Fosdick. Rockefeller Foundation, New York, N. Y. 1940. 72 p.

COURSES AND UNITS OF STUDY IN SCIENCE AND RELATED FIELDS

A Tentative Course of Study in Science. Public Schools, Youngstown, Ohio. 1940. 46 p. (Mimeographed.)

A Year of Nature Study in Our City. Curriculum Bulletin No. 10. By Hattie Charney and Ruth Berken. Board of Education of New York City, Division of Elementary Schools, New York, N. Y. 1940. 72 p.

Interdependence in Plant and Animal Life. University of Oregon Bulletin No. 12. By Stanley E. Williamson. University of Oregon Co-op Store, Eugene, Oregon. 1940. 26 p. (Mimeographed.) 25 cents.

Suggestive Course of Study for Science. Grades 7–10. Saginaw Public Schools, Saginaw, Michigan. 1939. 83 p. $1.00.

PAMPHLETS FOR THE SCIENCE TEACHER

A Bibliography of Nature Study. By Eva L. Gordon. Comstock Publishing Company, 124 Roberts Place, Ithaca, New York. 1940. 25 cents.

Agricultural Education: Organization and Administration. U. S. Department of Interior, Office of Education, Vocational Division Bulletin No. 13, Agricultural Series No. 1. Superintendent of Documents, Washington, D. C. 1939 (Revised). 50 p. 10 cents.

Aviation in Pennsylvania Schools. Pennsylvania Department of Public Instruction Bulletin No. 215. Department of Public Instruction, State of Pennsylvania, Harrisburg, Pennsylvania. 1939. 38 p.

Checklist of Safety and Safety Education. National Education Association, 1201 Sixteenth Street, N.W., Washington, D. C. 1939. 30 p. 25 cents.

Conservation Education. Pennsylvania Department of Public Instruction Bulletin No. 214. Department of Public Instruction, State of Pennsylvania, Harrisburg, Pennsylvania. 1939. 108 p.

Elementary School Field Experiences in Natural Science. By E. Laurence Palmer and others. Cornell Rural School Leaflet, Teachers' Number, Volume 34, No. 1, September, 1940. New York State College of Agriculture, Cornell University, Ithaca, New York. 1940. 64 p.

Equipment and Supplies. Association for Childhood Education, 1201 Sixteenth Street, N.W., Washington, D. C. 1940 (Revised). 37 p. 50 cents.

Exploring Your Community. By Gladys L. Potter. Association for Childhood Education, 1201 Sixteenth Street, N.W., Washington, D. C. 1940. 31 p. 35 cents.

1000 School Fires. National Fire Protection Association, Boston, Massachusetts. 1939. 72 p. 35 cents.

Problems and Topics in Safety Education. National Education Association, 1201 Sixteenth Street, N.W., Washington, D. C. 1940. 32 p. 25 cents.

Safety and Safety Education: An Annotated Bibliography. National Education of the United States, 1201 Sixteenth Street, N.W., Washington, D. C. 1939. 64 p. 25 cents.

Safety Education in the Rural School. National Safety Council, 20 North Wacker Drive, Chicago, Illinois. 1939. 55 p. 35 cents.

Safety Education Methods: Elementary School. National Safety Council, 20 North Wacker Drive, Chicago, Illinois. 1940. 95 p. 50 cents.

Safety Education Methods: Secondary School. National Safety Council, 20 North Wacker Drive, Chicago, Illinois. 1940. 104 p. 50 cents.

Science: A Study Guide for Teachers. By Hugh B. Wood. University of Oregon Curriculum Bulletin No. 5. Curriculum Laboratory, University of Oregon, Eugene, Oregon. 1939. 21 p. (Mimeographed.) 20 cents.

Book Reviews

Teaching of Science

Fraser, James Anderson. *Outcomes of a Study Excursion.* New York: Bureau of Publications, Teachers College, Columbia University, 1939. 84 p. $1.60.

This dissertation is the report of a study carried out at Teachers College, the second study relating to excursions reported in recent times.

The excursion involved twenty boys and twenty-six girls of the senior class of the Lincoln School. The excursion had the following three steps in teaching procedures: (1) preparatory study period starting January 3, 1938, and ending January 28, (2) the excursion beginning January 28 and ending February 8, and (3) the follow-up study beginning February 9 and concluding on March 16.

Places visited on the excursion included the plant and housing development of the American Bemberg Corporation at Norris, Tenn., power production and housing development at the Norris dam, the plant of the Georgia Power Company at Tallulah, Ga., the land management and soil erosion project at Clarksville, Ga., a land use project at Hoffman, N. C., a visit to Hampton Institute, and the Greenbelt housing project near Washington.

A battery of pre-tests designed to evaluate some of the study excursion outcomes were given before the start of the trip. Another series of tests were given after the excursion. Evaluation was also based on anecdotal records kept by the author, and from examination of student diaries.

In conclusion the author states "from examination of the demonstrated outcomes, it would appear to the author that all conditions of the study excursion being equal to those reported, the best single measure of the value and worth of a study excursion is the increase in knowledge or information."

—C.M.P.

Horton, Clark W. and the Committee on the Teaching of Botany, E. L. Stover, Chairman. *An Experimental Study of the Teaching of Botany in the Colleges and Universities of the United States.* Charleston, Ill.: Bulletin 119, Botanical Society of America, 1938. 46 p.

Questionnaires were sent to 638 institutions, mostly colleges and universities. Of these 40 per cent were returned filled in so they could be used in this report. The findings are summarized in extensive tabulations covering (1) the objectives to be achieved, (2) the content of the introductory course in botany, (3) teaching methods and (4) the evaluation of student achievement.

It is interesting to note that even college teachers of botany express the aims of their course in such indefinite terms as "To teach students about plants," "To acquaint the students with the out-of-doors." It is a pleasure to note, however, that on the check list of objectives, "Disposition to open mindedness, willingness to be convinced by evidence," is voted first place while "ability to use a manual or key in the identification of unknown plants" is near the bottom. Every teacher of biology should read this list.

Every such teacher should see in Table 5 what items on the content of the course are voted the more important by fellow teachers. Some more convincing basis should ultimately be secured for the selection of curriculum topics than mere consensus of opinion though that is better than individual opinion.

Some of the most interesting reading is provided by problems raised by the teachers themselves. One is rebellious because he can not devote his time to the able students rather than the dullards. Another suggests that freshman botany be taught in the field during the summer rather than indoors during the winter.

The evaluation of student achievement is more fully treated in Bulletin 120. Bulletin 119 is thought-provoking and is highly commended.

—E.R.D.

Horton, Clark W., for the Committee on the Teaching of Botany in American Colleges and Universities. *Achievement Tests in Relation to Teaching Objectives in General College Botany.* Charleston, Ill.: Bulletin 120, The Botanical Society of America, 1939. 71 p. (Copies may be obtained from E. L. Stover, Chairman.)

The committee approaches its task with this question in mind, What changes is the teacher really trying to bring about in students in a college course in general botany? Unless test papers are scored, returned to the student and his errors discussed with him tests are relatively valueless, the committee thinks. "Detailed information . . . is lost early, while knowledge of important generalizations which the student has learned to apply are retained longer."

Here are some of the chapter headings: (3) Understanding the meaning of technical terms, (6) The use of information in the solution of problems, (7) Aspects of thinking; the interpretation of data, (8) The nature of proof, (10) Work and study abilities, (11) Attitudes, appreciations, interests.

There are given 92 examples of tests collected from various colleges and universities and classified under the several chapters. Under chapter 7, for instance, are given tests to see how well

students have acquired skill in the interpretation of data. The bibliography of about 70 titles is confined with few exceptions to articles dealing with teaching at college level.

The report is very worth while for every teacher of biological subjects in high school or college. It will help him think in terms of objectives other than the mere acquisition of information.

—E.R.D.

LEMON, HARVEY B., AND MARSHALL, FITZ-HUGH. *The Demonstration Laboratory of Physics at the University of Chicago.* Chicago: The University of Chicago, 1939. 127 p. $1.50.

The "demonstration laboratory," at present in operation only in physics, was originally started as a "physics museum." So successful was this "physics museum" (40,000 students and visitors in seven years) in providing some first-hand contact with laboratory work not available in the conventional laboratory set-up, that the set-up has been greatly extended. The expansion has resulted in the Ryerson Demonstration Laboratory. Here 152 experiments are set up to demonstrate some principle, basic idea, or technique in physics.

This laboratory serves the following groups: (1) freshmen who are required to be examined on the content of a three months' intensive work in physics, (2) pre-professional sophomores and juniors majoring in biological and physical science, (3) professional graduate students of physics, mathematics, or chemistry who expect to combine continued scholarship in their chosen field with the teaching of it and perhaps one of the more closely related sister physical sciences, (4) teachers of few or many years experience who return to the University at periods for review, refreshment, or further study to round out earlier incompleteness of training, and (5) the lay public.

The various demonstration experiments are described, often with an accompanying photograph. An appendix contains classified practical details as to the setting-up and putting into operation the demonstration laboratory. Such a laboratory would seem to offer unlimited teaching possibilities and is the probable answer to the question of the kind and method of successfully conducting laboratory work in connection with science survey courses.

—C.M.P.

BROWN, H. EMMETT. *The Development of a Course in the Physical Sciences for the Senior High School of the Lincoln School of Teachers College.* New York: Bureau of Publications, 1939. 205 p. $2.25.

The immediate purpose for which this study was undertaken was the development of course materials in science for the last two years of the senior high school of Lincoln School. The guiding philosophy was that set forth in the report of the Science Committee of the Commission on the Secondary Curriculum of the Progressive Education Association.

Fifteen teaching units are set up, one unit of which is described in detail. Certain criteria of needs were used as guides in selecting the units. Units were set up in terms of generalizations. These units were as follows:

(1) The region now occupied by New York City has come into existence as the result of a long sequence of geological events involving forces which today, as in the past, have operated to change the surface of the earth.

(2) The climate of a given region is the result of the operation of a number of natural causes—wind, topography, etc. Climatic conditions are correlated with racial characteristics and economic and social conditions of the peoples of the earth. Soil erosion is the result of the combined effects of climatic conditions, geologic forces, and of man's faulty use of the soil.

(3) Moving bodies, be they members of the sun's family of planets or objects on the earth's surface, seem to move in accordance with the same laws. Knowledge of these laws furnishes an intellectual basis for social action in the control of the speed of automobiles.

(4) The solar system is part of a universe which is vast in extent. Man has been able to discover organizations of stellar material into various systems.

(5) Almost all available energy on the earth's surface is derived directly or indirectly from the sun in the form of radiation, important effects of which are called light and heat.

(6) The increased application of energy to man's uses, resulting mainly from the discovery of ways to utilize the energy of fuels in doing the work of the world, has wrought profound effects upon present-day life.

(7) Today's technological civilization has been made possible by the increased use of electricity, a form of energy capable of transmission over long distances.

(8) Energy in the form of waves constitutes an important means by which information is received and imparted.

(9) The development of techniques for reflective thinking and the perfection of more precise measuring instruments were essential steps in the growth of man's knowledge of chemical change. Chemical changes are important because of their use by industry. Ideologically the concept of chemical change furnishes a basis for systematizing many hitherto unrelated phenomena.

(10) The process by which our natural resources of fuels are made available for consumer's use is fundamental to our present civilization.

(11) The use of metals has played and continues to play a fundamental part in our present civilization.

(12) Chemical and physical changes are the basis of all the activities of living organisms.

(13) Modern scientific technology is equally capable of being used for the good or the ill of mankind.

(14) Information and techniques of science may be employed to insure the consumer a higher quality of goods.

(15) The development of scientific knowledge and techniques has reached such a point as to make possible a better living for everyone as judged by all the factors that constitute complete living.

Unit nine is presented in detail, and the other fourteen units briefly described as to the choice of the unit, content, and values and needs. At Lincoln School, the first eight units constitute the first year's work and the last seven units the second year's work. —C.M.P.

Text Books and Manuals

Williard, Lester R. and Winter, Charles S. *Experiences in Physics.* Boston: Ginn and Company, 1939. 662 p. $1.92.

This book represents a real advance in secondary physics textbook writing. Slowly but surely physics textbook writers are planning their texts in accordance with the more successful organization and style commonly used in general science, biology, and chemistry textbook writers.

The authors are instructors in physics in the Thomas Jefferson High School at Elizabeth, New Jersey. They have attempted to make the content have more personal and social consequence, to arouse a real interest in physics and allow for a maximum of classroom and individual variation.

There are six units of twenty-four chapters. The units deal with the nature of matter, forces, heat, sound, light, magnetism and electricity. The illustrations are well done, the style unusually appealing, and the larger size page and type should offer a maximum of comfort in studying the lessons. It seems a real pity that many students have to use physics texts they do, when books like this one exist—so attractive in style and illustrations, with a major emphasis on the social, personal usefulness of physics.

—C.M.P.

Millikan, Robert Andrews, Gale, Henry Gordon, and Edwards, Charles William. *A Manual of Experiments to Accompany a First Course in Physics for Colleges.* Boston: Ginn and Company, 1938. 221 p. $1.10.

There can be no question about the quality of the material covered in this laboratory manual by these well-known authors. This new manual is a revision of their older manual. Much new material has been included and wherever possible, stress has been placed upon the principles involved and their application rather than upon the mere working of the experiment for the sake of working an experiment because tradition has said that every student of physics has to work in the laboratory. It is easy to see that the authors are attempting to follow the trend in modern education by setting up the experiments to be performed in terms of specific problems. The manual does not set the experiments up as individual problems in that the experiments are not in the usual form of statement of a problem such as stating it in the form of a question. However the problem as such is clearly defined by the authors so the experiment is still a problem in need of solution. There is a good deal of the tradition in the form of the experiments and in the method of their solution. The experiments are well organized and well set up as to completeness of needed explanations and techniques for the successful conclusion of the experiment. All the drawings used are simple and easily understood by the student. There is a wide variety of experiments available for assignment to the student to meet the needs of the type of student and to coordinate classroom work with the laboratory work. The appendix is very complete and contains a great deal of useful information for ready reference by the student. The manual can be used with most any text and can be adapted to any style of teaching. The problem solving method of teaching will lend itself in such a way that the manual will serve as a most valuable source book or reference book.

—F. L. Herman.

Holmes, Harry N. *Introductory College Chemistry.* New York: The Macmillan Company, 1939. 619 p. $3.50.

This book is especially good from the standpoint of physical set up, presentation of subject matter and arrangement of material.

Wise use of bold type, print of various size, fine illustrations and diagrams to supplement the printed information as well as the reasonable size of the book make the students feel that a subject, strange to them, is not unsurmountable. The student will find it readable and interesting. The insertion of bits of information of practical value and human interest is in no small way responsible for this.

The subject matter is presented clearly and simply without including a mass of detailed information that only confuses the student who has little background for the course. Modern concepts such as those of atomic structure and the Bronsted theory, presented in a manner readily understood by the student simplify the teaching to a wide extent.

—Ruth Gerber.

Conant, James Bryant. *The Chemistry of Organic Compounds.* New York: The Macmillan Company, 1939. 658 p. $4.00.

The author has succeeded in producing a nice balance between theoretical and applied organic chemistry. A splendid chapter on determination of structure and methods of synthesis gives the student a good opportunity to comprehend the

problems facing the organic chemist in the laboratory as well as an excellent review of the use of basic principles which have been treated extensively just preceding it. In addition, a number of fine diagrams of apparatus elucidate many processes for the beginning student.

Sufficient space is allowed for discussion of the recent discoveries that show the modern trend in organic chemistry. Of special interest is the material on the structure of sterols, harmones and vitamins. The modern treatment shows the bearing of physical chemistry on organic chemistry at the present. —Ruth Gerber.

BRADBURY, ROBERT H. *A First Book in Chemistry.* New York: D. Appleton-Century Company, 1938. 639 p. $1.80.

This is a revised edition of a text well known to many chemistry instructors. Several sections of the book have been rewritten to include new industrial processes, such as extracting bromine from sea-water, and the Downs process of making sodium from sodium chloride. The summary and study plan at the end of each chapter should be especially helpful to the student. The book is well illustrated by drawings and photographs. —Roy V. Maneval.

STEMEN, T. R. AND MYERS, W. STANLEY. *Syllabus and Handbook for Biology.* Oklahoma City: W. C. Bonney, 1939. 69 p. $0.35.

This inexpensive syllabus and handbook is not intended to take the place of the workbook or laboratory manual, but to be used with them. Classroom and laboratory activities with possible student projects are given in outline form. Lists of films suitable for using with each unit are given. There are forty-seven pages of helps to pupils and teachers in the forms of keys, charts, drawings, and glossaries.

—Roy V. Maneval.

MILLER, RUSSEL D. *Practical Physics for Agriculture.* Ames, Iowa: Russel D. Miller, Iowa State College of Agriculture and Mechanical Arts, 1938. 127 p. $1.50.

Here is one answer as to what kind of physics students who will be connected with farming activities, need. Naturally, the needs are quite different from those of other individuals. Yet in many rural or small-town high schools, students who will continue to live on farms, are enrolled in physics courses that make few, if any, applications to the local environment in which they are now living, and will probably continue to live.

This is the basal college textbook used at Iowa State College in the physics course for agricultural students. It represents quite a contrast from the usual physics textbook, even those textbooks used in classes of non-physics or non-science majors. The applications are those found in the environment of farm workers. Mathematical concepts have been reduced to a minimum.

Sections are as follows: (1) producing heat energy from radiations, (2) producing heat energy by friction, (3) producing heat energy from chemical energy, (4) producing heat energy from electrical energy, (5) producing heat energy by a change of state, (6) transfer of heat energy, (7) the frost hazard, (8) the weather and how it is made, (9) producing electrical energy by friction, (10) producing electrical energy from chemical energy, (11) producing electrical energy by cutting a magnetic field, and (12) applications of electrical energy.

—C.M.P.

FLETCHER, GUSTAV L. *Laboratory Exercises in Physiography.* Boston: D. C. Heath and Company, 1939. 162 p. $0.68.

This laboratory manual contains sixty-four exercises. For each exercise, there are detailed step-by-step directions, a stated objective, discussion, questions, optional questions, conclusions, and a list of needed supplies. Although the material in the manual is largely indoor laboratory and map work, the author suggests that most of the laboratory work should be work in the field.

The exercises seem to be well-selected and can be used with any textbook in physiography.

—C.M.P.

LOBECK, A. K. *Geomorphology.* New York: McGraw-Hill Book Company, 1939. 731 p. $4.50.

This is an elementary textbook in the study of landscapes. The title, *Geomorphology,* is equivalent to the older term, *"physical geography."* This book is in distinct contrast to the usual run of beginning college textbooks in geology or in other sciences. An unusually large number of photographs has been introduced in order to put before the reader an actual image of the features described. These pictures have been assembled usually at the beginning of each chapter instead of being distributed through it. The text and explanatory illustrations are placed on the same page or opposite each other, so that each two or occasionally four pages constitute a unit. This arrangement keeps the illustration in view while the material relating to it is being read. The diagrams are especialy pertinent. The textual material actually constitutes only one-third the bulk of the book.

The author, Professor of Geology at Columbia University, is known as a preeminent classroom teacher of science. This skill he has translated to his textbook. The result is one of the most attractive, optically appealing, readable textbooks in the whole realm of science. —C.M.P.

WRIGHT, HARRY N. *First Course in the Theory of Numbers.* New York: John Wiley and Sons, 1939. 108 p. $2.00.

This book, written to serve as a textbook for a one semester course, follows the usual outline of courses in The Theory of Numbers. The book is clear, precise, logical, and teachable.

—E. F. Allen.

Science Reference Books

Symposium. *The Little Technical Library Photographic Series.* Chicago: Ziff-Davis Publishing Company, 608 S. Dearborn St.), 1939. $0.50 each.

This is an excellent series of ten pocket-sized books on various phases of photography. The several authors are well-known authorities in the field of photography. The information is, for the most part, comprehensive, well-illustrated and quite practical. The books are intended for the beginner and the amateur. Photography clubs, science clubs, and science teachers would find the books valuable sources of information.

The authors and titles are as follows:

1. Dobbs, W. E., and Savage, Charles A. *Your Camera and How It Works.* 130 p.
2. Bernsohn, Al, and Davera. *Developing, Printing, and Enlarging.* 93 p.
3. Shank, W. Bradford. *Filters and Their Use.* 95 p.
4. Heilbron, Kenneth. *Composition for the Amateur.* 93 p.
5. McKay, Herbert C. *Movie Making for the Beginner.* 98 p.
6. Dmitri, Ivan. *Color in Photography.* 94 p.
7. Lambert, Harold. *Child Photography.* 94 p.
8. Seymour, Maurice, and Simons, Syd. *Home Portraiture and Make-up.* 110 p.
9. Anonymous. *Tricks for Camera Owners.* 157 p.
10. Fenner, Jr., Frank. *A Glossary for Photography.* 147 p.

—C.M.P.

Teale, Edwin Way. *The Boys' Book of Photography.* New York: E. P. Dutton and Company, 1939. 252 p. $2.00.

Recently one of our best known, most readable science writers, has turned to writing science books for boys of the junior-senior high school level. His book on insects is now followed by one on photography. Having long been an enthusiastic photographer himself, this book is contagious. If you don't want your science students to "catch" photography, you had better "quarantine" them from this book.

The author writes informatively, enthusiastically, spiritedly. Many anecdotes throughout the book keep it chatty and informal. Also, 31 full page photographs and more than 40 diagrams illustrate and enliven the text.

All phases of photography are covered with numerous hints on how to get better pictures and have more fun with the camera. An excellent book for all amateurs and beginners in photography, the book is also recommended as unusually good reading for those who do not indulge, but would like to know something about this rapidly growing, fascinating hobby.

—C.M.P.

Natkin, Marcel. *Fascinating Fakes in Photography.* San Francisco: Camera Craft Publishing Company, 1939. 72 p. $2.00.

Photographic fakes arouse the curiosity of everyone, whether amateur, professional, or merely "on-looker." Often, one sees a picture and knows that it was faked in some way. But just how? This book takes you behind the scenes, so to speak, and reveals how many unusual fake pictures are actually made. Most fakes are readily detected.

This treatise however is intended more for the professional and the amateur, than for popular reading. Numerous illustrations add to the usefulness of the book. Among the many fakes described and illustrated are: shadowgrams; smears; screens; relief; photomontage by cutouts, by composition, by superposition, by superimpression, by repetition of a negative, by double printing, and by combination; distortions; and solarization.

—C.M.P.

Anonymous. *How To Make Good Movies.* Rochester: Eastman Kodak Company. 230 p. $2.00.

Amateur movie fans are as numerous today as were amateur photographers a couple of decades ago. The techniques have been so simplified and the costs so reduced that practically anyone can become an amateur movie-maker. Numerous books have been written on making motion pictures, but none have been superior to this one with its many illustrations (more than 600) and practical suggestions of procedure in simple, non-technical language.

Topics discussed include: camera angles, close-ups, clouds, color-film, composition, duplicates, double exposure, editing, fades, film, filters, finishing, focusing, lenses, lighting, photo-floods, posing, projection, scenics, silhouettes, slow motion, splicing, stunts, and trick shots.

—C.M.P.

Raymond, Percy A. *Prehistoric Life.* Cambridge: Harvard University Press, 1939. 324 p. $5.00.

Life that existed during the past history of the earth, is revealed through a study of fossils. This study has long involved the major activity of many individuals, and attracted the attention of untold thousands. The questions, Whence, Whither, Why, are still man's most baffling questions.

In this volume, the author, professor of paleontology at Harvard University, traces the history of life through the five or six hundred million years of which fossils afford a record. Professor Raymond traces the main lines from the invertebrates of the early Paleozoic through transition forms, partly invertebrate and partly vertebrate, in the Mid-Paleozoic, to the primitive amphibians and reptiles of the late Paleozoic, and thence to the rise of simple mammals in the early Mesozoic and in the Cenozoic. He also discusses animals not in the main lines, such as insects, which have followed paths that may ultimately lead to the control of the earth, and others, like the mighty dinosaurs which have followed paths to extinction.

The language is non-technical and in difficulty, not beyond the understanding of the average per-

son. High school students should find the volume most interesting. It is an excellent book for all teachers of science especially elementary science, general science, biology, and biology survey course teachers. The book should prove an authoritative reader and a source book for secondary biology and college survey courses.

—C.M.P.

BIGGER, JOSEPH W. *Man Against Microbe.* New York: The Macmillan Company, 1939. 304 p. $2.50.

The war between man and microbe has been raging for thousands of years. Within the last fifty years, man has acquired some control over microbes which may in time give him the complete mastery. The beginning of man's control starts with the work of Leeuwenhoek in 1675, when he made his own microscope. This book gives in non-technical language the history of microbiology and the pioneers who first studied microbes. The greater portion of the book deals with today's warefare between disease-producing microbes and the human race.

This would be an excellent reference book for a high school science library.

—Roy V. Maneval.

TEALE, EDWIN WAY. *The Boys' Book of Insects.* New York: E. P. Dutton and Company, 1939. 237 p. $2.00.

Beetles, butterflies and moths, ants, termites, walking sticks and praying mantises, wasps, dragonflies, water insects, bees, the real bugs, flies—the lives and habits of all of them are told about in this captivating book. Not only does the author tell extensively about insects, but he tells how to explore among the insects and how to make equipment for collecting, rearing, studying, and preserving many of them. One of the many interesting chapters tells how to keep an insect zoo.

This attractively bound volume is well illustrated by both photographs and drawings by the author. Any boy or girl of junior high school age would enjoy reading and owning this book.

—Roy V. Maneval.

SNELL, FOSTER DEE, AND SNELL, CORNELIA T. *Chemicals of Commerce.* New York: D. Van Nostrand Company, 1939. 542 p. $5.00.

This book is intended as a source of information on the composition of actual commercial products. It is not a chemical dictionary which gives a brief description of all chemical compounds. Much useful information, occasionally quite detailed, is given about many chemicals used in commerce. Classification is by type of compound, so, closely related substances occur in the same chapter.

Altogether this book is an excellent, quick source of summarized information. As the material is as non-technical as possible, writers, and science survey course teachers as well as laboratory technicians and chemists will find this book a useful, handy source of reference. It will serve as a valuable reference book for the science book shelf.

—C.M.P.

HOLBROOK, STUART H. *Iron Brew.* New York: The Macmillan Company, 1939. 352 p. $2.50.

Iron Brew presents the human side of steel. An account of the iron and steel industry could be dry and uninteresting. This account is decidedly not. The author writes with ease, vividness, picturesqueness. Much scientific economic information is presented but in a way to make iron and steel take on something of a romantic personality. Both the raw materials and the processing are discussed.

The history of the discovery and development of the iron ore deposits of Minnesota and Michigan is vividly portrayed, as is also the development of the various processes of making steel. Much of the material was gathered from men connected with the early history of the development of the iron industry. Emphasizing the human aspects, a great deal of attention is paid to Carnegie, Gary, Schwab, and others.

High school chemistry and physical science students will enjoy reading this popular treatise.

—C.M.P.

BENNETT, H. *Standard Chemical and Technical Dictionary.* New York: Chemical Publishing Company, 1939. 638 p. $10.00.

This is a condensed technical word-book that students, writers, scientists and others who need assistance in keeping up with the many new chemical, physical, mathematical, engineering and technical terms, will find must useful and convenient. There are over 25,000 definitions.

A special section is devoted to the explanation and the proper naming of organic compounds. Complete cross-references are used. Matter of similar nature is grouped. Even the most complex organic compound can be found readily.

Altogether, this dictionary is a real compendium of scientific knowledge and fills a long felt need in a field that is both complicated and rapidly growing.

—C.M.P.

TURNER, C. E., MORGAN, NELL JOSEPHINE, AND COLLINS, GEORGIE B. *Home Nursing and Child Care.* Boston: D. C. Heath and Company, 1939. 276 p. $1.20.

The subject is presented "in the form found best suited to students who have profited by a well-organized health-training program at earlier age levels. . . . Classes at the upper-junior-high-school and lower-senior-high-school levels will find this book a useful and practical classroom guide." Specific, detailed and straight forward information and guidance is given with regard to the practical problems of preventing sickness and caring for sickness in the home, care of infants and young children, and personal hygiene especially applied to childhood and youth.

—O. E. Underhill.

Green, Charlotte Hilton. *Trees of the South.* Chapel Hill: The University of North Carolina Press, 1939. 551 p. $2.50.

This book describes the common trees of the south, but it is not a "key" book in the usual sense of the term, although trees are described according to families. It will serve excellently for a guide book, but is a most readable book in addition. It would make a fine reference book for biology classes and for all persons interested in knowing more about the trees of the south. The book can also be read with profit and enjoyment by people more interested in trees of the north, as most trees are common to both sections.

Part I discusses the following aspects of the tree: (1) living with trees, (2) the tree and its parts, (3) tree flowers, fruits, and seeds, and (4) gifts of the trees. Part II describes the broad-leaf trees and Part III, the conifers.

There are usually two full pages of excellent photographs for each tree described—one page showing the tree in its native habitat, the other a group of photographs of bark, leaf, bud, blossom, or other detail which will aid in identification. This book should serve a long-felt need for a book on trees found in the south.

—C.M.P.

Smith, Elliott Dunlap. *Technology and Labor.* New Haven: Yale University Press, 1939. 222 p. $2.50.

This is a study of the human problems of labor saving, published for The Institute of Human Relations.

The study in order to obtain comparable results, was confined to a single branch of a single industry. The study selected was the labor-saving development in cotton weaving called by the management the "multiple loom" or "extended labor" system and by labor, "the stretch-out." Eighteen cotton mills were studied. The material was obtained by first hand observation at mills and in mill communities. Financial, merchandising, technical, and managerial as well as labor and social factors and development were studied.

No definite conclusions are drawn from the study, but the responsibility of the management for satisfactory adjustment to the new technology is emphasized. This economic-social treatise, because of its relation to technology, is of special concern to the science teacher. To what degree is technology (science) really responsible for the widespread unemployment that exists today? This is still an unanswered, albeit, important question.

—C.M.P.

Orr, William M. *The Fingerprints of God.* Nashville: Cokesbury Press, 1939. 128 p. $1.00.

This is a book of fifty well-told stories about the wonders of the heavens, the earth, trees, flowers, seeds and small creatures in which the author reconciles observations in science with those in religion. Scientific phenomena, to him, are evidences of the handiwork of the Creator and Preserver of the world—veritably *The Fingerprints of God.* The book has a tinge of the scientific textbooks of half a century ago, when such scientists as the botanist, Gray, and others strived to show the handiwork of God in natural phenomena.

—C.M.P.

Franck, Rachel Latta. *I Married a Vagabond.* New York: D. Appleton-Century Company, 1939. 241 p. $2.50.

I Married a Vagabond tells of the author's experiences while traveling with her husband to the West Indies, Japan, China, Korea, Scandinavia, France, and England. The author is the wife of Harry A. Franck, noted vagabond voyager, whose travel books have delighted thousands. Here you get a chance to see how the "better half" has reacted to all the "going ons" of her famous husband. Seemingly, she gets as much enjoyment and thrill out of traveling as does Mr. Franck. She presents a side of life not commonly found in travel books. Somehow she gets more of the "spirit" and "feel" of the country as she records interesting and unusual incidents. Especially this seems to be true about China which is extremely well done. The book indirectly points out the striking contrast in scientific applications between most countries and the United States.

—C.M.P.

to be
work
ade-
first
r for
bjec-
al is-
of the
and
5.

e

e and
school.
sident
today
eld of
educa-
gh 170
in all
appeal
y con-
List

Ave.
rk